

3 Cells

Cells are the basic units of all living things. The first cell appeared on Earth about 3.5 billion years ago. Today, there are many different kinds of cells. The differences in the cells of organisms are sometimes used

to classify them into groups. Although cells may vary in their size, shape, contents and organisation, they all perform functions that are involved in keeping the organism to which they belong alive.

OVERARCHING IDEAS

- Patterns, order and organisation
- Form and function
- Stability and change
- Systems

SCIENCE UNDERSTANDING

Cells are the basic units of living things and have specialised structures and functions.

Elaborations

Examining a variety of cells using a light microscope, by digital technology or by viewing a simulation

Distinguishing plant cells from animal or fungal cells

Identifying the organs and overall function of a system of a multicellular organism in supporting the life processes

Identifying structures within cells and describing their function

Recognising that cells reproduce via cell division

Describing mitosis as cell division for growth and repair

THINK ABOUT CELLS

- What's all the fuss about stem cells?
- How can you make small things look bigger?
- Which are bigger, viruses or bacteria?
- What does Schwann have to do with cells?
- Why are beaches tested for the presence of *E. coli*?
- How does a cell become a clone?
- Why don't all cells look the same?



Who am I?

Microscopes are responsible for opening a whole new world to us. They have allowed us to see beyond our own vision. The more developed these microscopes become, the more detail and wonder we are able to observe—but often, rather than answering our questions, they provide us with many more.

The three photos below and the one on the previous page show parts of different animals. They were taken with a scanning electron microscope, which allows us to see more detail of the surface of specimens.



OBSERVE, THINK AND SHARE

- 1 Look carefully at the photos of each animal part and think about:
 - (a) what they could be
 - (b) what they may do
 - (c) who they may belong to.
- 2 Talk through your suggestions with your partner, adding all of the details that you have both observed onto a sheet of paper.
- 3 Two of these photos show parts of one type of animal, and the other two are of different animals. Does that information change the way that you look at the details? Which animal do you think two of the parts belong to? Brainstorm to decide which two animals the other parts could belong to.
- 4 Suggest other sorts of information that may be helpful in determining who these parts belong to and what they are used for.

A whole new world

A whole new world was discovered just over 400 years ago when an English inventor and scientist used magnifying lenses to observe the basic units of which all living things are made. This led to a new way of thinking about living things that required a new scientific language, new classifications and new inventions to find out more about this new world.

The discovery of cells

In the seventeenth century, Robert Hooke looked at thin slices of cork under a **microscope** (= very small + view) that he had made himself from lenses. He observed small box-like shapes inside the cork. He called the little boxes that he saw **cells**. Microscopes opened up a whole new world that had never been seen before.

Using microscopes to carefully observe different living things showed that they also were made of these tiny basic units. As the **magnification** provided by microscopes increased, it could be seen that, although the basic structure of cells was similar, there were quite a few differences. Different groups

An early microscope used by Robert Hooke



of organisms often contained different types of cells. It was also discovered that different types of cells could be found within an individual organism.

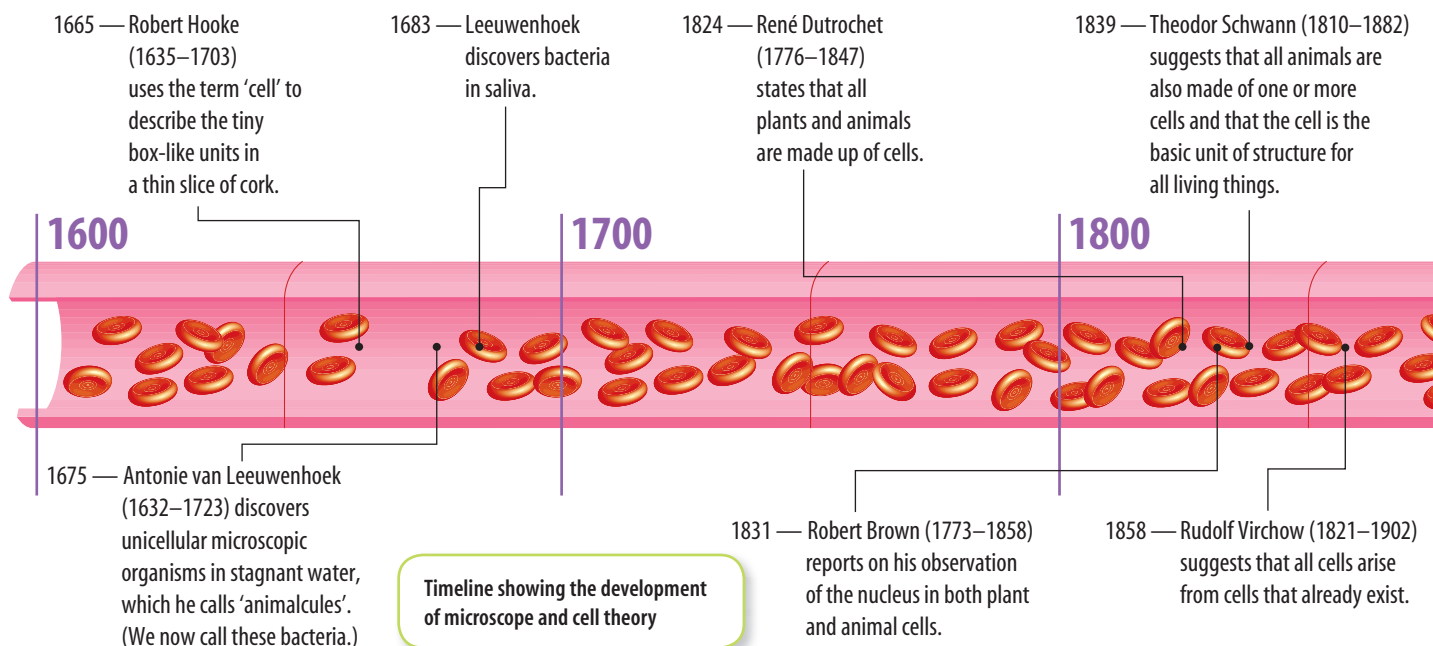
HOW ABOUT THAT!

There are many different types of scientists who study cells. Examples include bacteriologists, cell biologists, clinical microbiologists, cytologists, electron microscopists, genetic scientists, medical microbiologists and virologists.



WHAT DOES IT MEAN?

The word *microscope* comes from the Greek words **micrós**, meaning 'small', and **skopein**, meaning 'to view'.

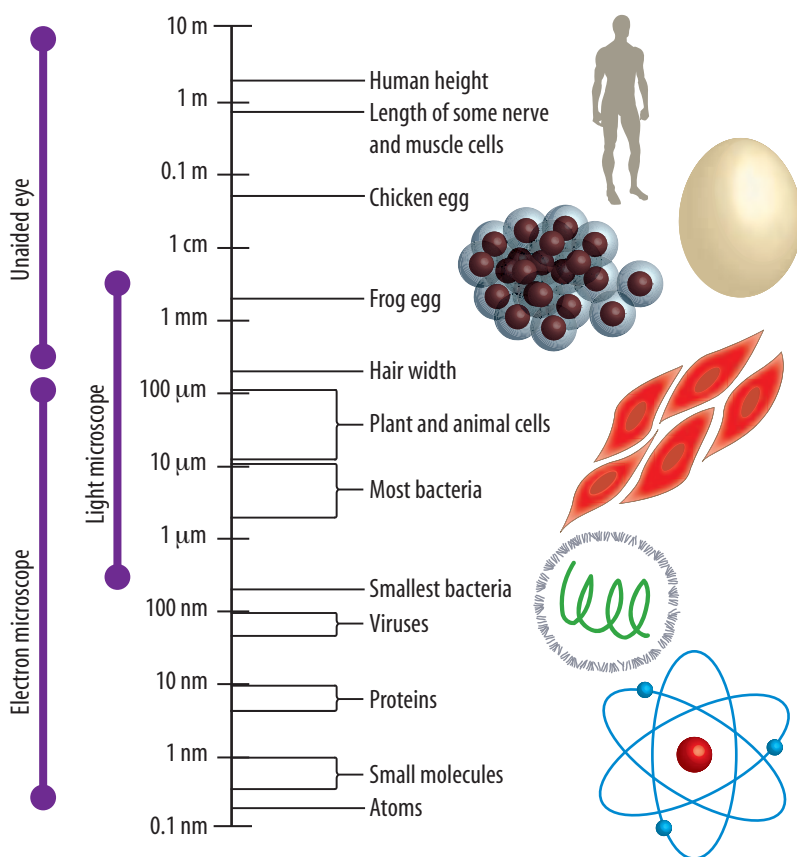


Little, littler, littlest . . .

With the development of instruments such as microscopes, scientists needed to find words to describe some of the tiniest lengths and time scales in nature. They wanted some simple names to describe, for example, a billionth of a billionth of a metre.

In the microscopic world, there is often a need to describe things in much smaller terms than the units of measurement that you already know, such as metre, centimetre and millimetre. In describing cells, other units of measurement, such as micrometre (μm , also called micron) and nanometre (nm), are often used.

In 1964, experts in weights and measures from 35 nations met at a palace near Paris and decided to officially adopt a new prefix of 'atto', which means $1/1\,000\,000\,000\,000\,000\,000$ (or 10^{-18}) of something. At the time it seemed impossible to measure something so small — but it doesn't seem so difficult now. Scientists are developing



technology that can measure attoscale quantities. There are a number of very exciting 'attoworld' investigations and discoveries underway. With new technologies yet to be developed, how much more will we be able to 'see' and what will we find?

Unit	Symbol	No. units in 1 m
Millimetres	mm	1000
Micrometres	μm	1 000 000
Nanometres	nm	1 000 000 000

Scope 'to go'

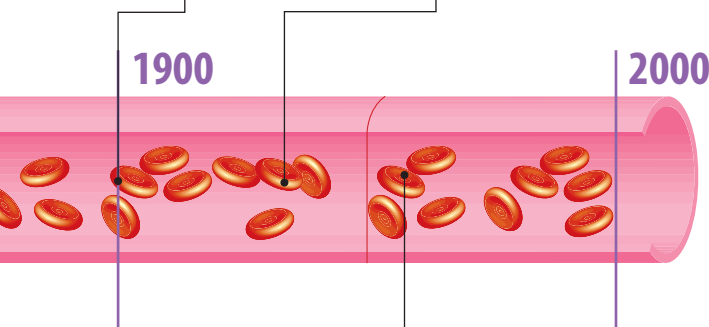
There are an increasing number of portable microscopes being invented that can open our eyes to the microbial world no matter where we are. Some of these are connected to camera-phones and can be used to diagnose a variety of diseases. The images can then be sent by internet to specialists for additional investigation. This may become an important field tool for the diagnosis of malaria, tuberculosis and other dangerous diseases.

20th century — Development of the microscope continues.

1933 — Ernst Ruska (1906–1988) builds the first electron microscope.

PRESENT DAY — Development of:

- transmission electron microscopes, which show the internal structures of cells
- scanning electron microscopes, which show images of the surface features (often involve coating the specimen with a very thin layer of metal atoms)
- superfast electron microscopy, which enables scientists to capture the movement of atoms (visit the **Electron strobe** weblink in your eBookPLUS).



1953 — Frits Zernike (1888–1966) wins Nobel Prize for inventing the phase contrast microscope.

eBook plus

eLesson



Inside cells

Learn about cells and organelles in this animated video lesson.

eles-0054

Portable microscope for spotting and tracking disease



Looking like a grotesque eyeball, this hand-held microscope magnifies your specimens to two hundred times their normal size.



UNDERSTANDING AND INQUIRING

REMEMBER

- 1 State a feature that all living things have in common.
- 2 Suggest why Hooke called the objects that he observed under the microscope 'cells'.
- 3 Do all cells look the same?
- 4 Explain the importance of the microscope to biology.
- 5 List five types of scientists that study cells.
- 6 Suggest a function for portable microscopes.

THINK AND REASON

- 7 Use the timeline on pages 60–1 to answer the following questions.
 - (a) In which year did Hooke use the term 'cells' to describe his observations of cork slices?
 - (b) What did Virchow suggest in 1858?
 - (c) In which substance did Leeuwenhoek discover bacteria?
 - (d) When did Ruska build the first electron microscope?
 - (e) State the differences between cell observations made with a scanning electron microscope and those with a transmission electron microscope.

INVESTIGATE AND CREATE

- 8 If you were living 300 years ago, how might you react to being told that you were made up of cells? What might cause these reactions? Construct a story, play or cartoon that answers these questions.
- 9 Find out how a light microscope works and design and construct your own model.
- 10 Create your own picture book or PowerPoint presentation that would teach primary students about the discovery of cells.

INVESTIGATE

- 11 Robert Hooke has been described as having 'a mechanic's mind and an artist's heart'. He wove

these traits into his work as a scientist and inventor. Research and report on one of the following:

- his work with Robert Boyle
 - his debate with Isaac Newton on the nature of light and gravity
 - Hooke's Law
 - his invention of the iris diaphragm in cameras
 - Hooke and micrography.
- 12 Research and report on one of the following:
 - Ernst Ruska's Nobel Prize for Physics
 - reasons why Frits Zernike has been described as 'a pioneer in forensic science'
 - examples of recent microscope inventions
 - examples of Australian research using electron microscopes.
 - 13 Research one of the following types of scientists; imagine you are such a scientist and create a journal that describes a discovery you have made: bacteriologist, cell biologist, clinical microbiologist, cytologist, electron microscopist, genetic scientist, medical microbiologist, virologist.
 - 14 In 2009, expatriate Australian Professor Elizabeth Blackburn was jointly awarded the Nobel Prize for Medicine for her discovery of telomeres and telomerase. Find out more about her discovery and its relevance to cells and microscopes. Report your findings in a PowerPoint presentation.

eBookplus

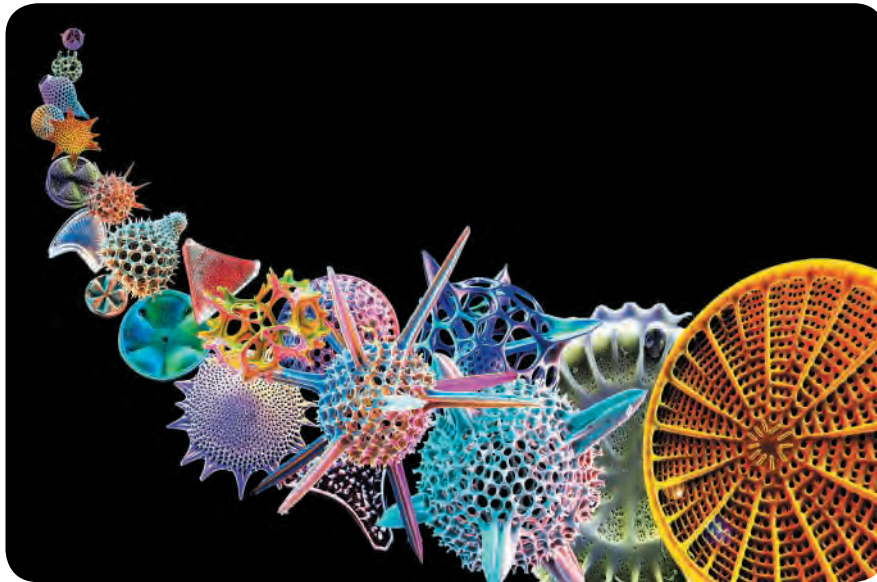
- 15 Visit the **Robert Hooke** weblink in your eBookPLUS and investigate why he used the term 'cells' for the little box-shaped structures he observed in cork. What did people think living things consisted of before Hooke's discovery of cells? Write a story about your findings.

work
sheet

3.1 History of the light microscope

Focusing on a small world

Just because you can't see something doesn't mean that it's not there. Microscopes can be used to make small objects appear bigger, so that we can see what was previously invisible to us.



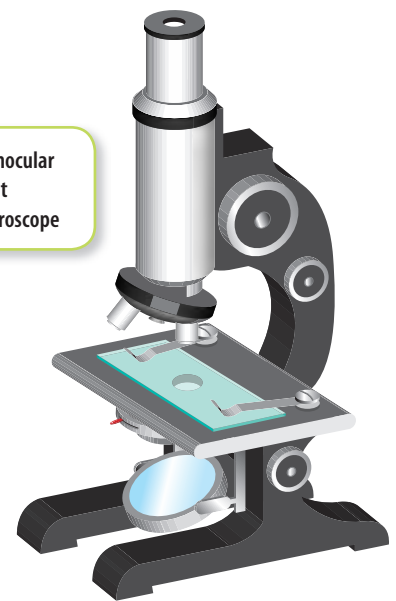
This coloured 'electron micrograph art' shows examples of diatoms, which belong to a group of photosynthetic, single-celled algae.

Types of microscopes

The two main types of microscopes are light microscopes and electron microscopes. **Light microscopes** use light rays whereas **electron microscopes** use small particles called electrons.

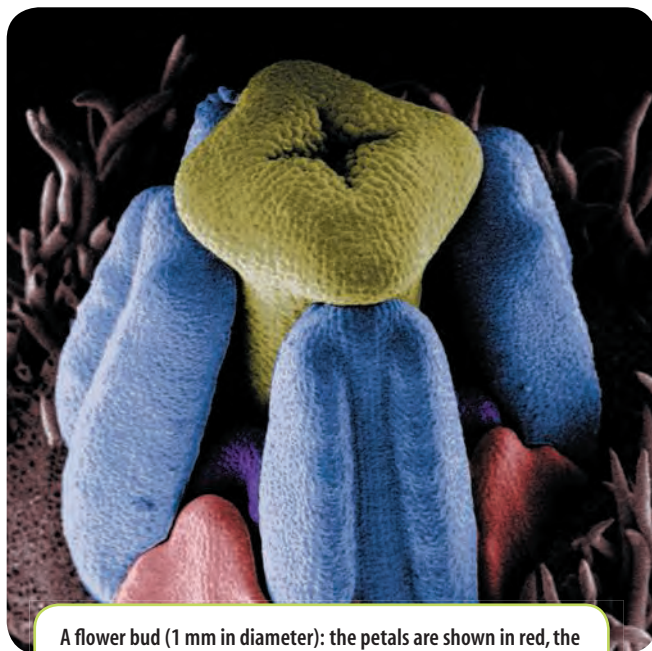
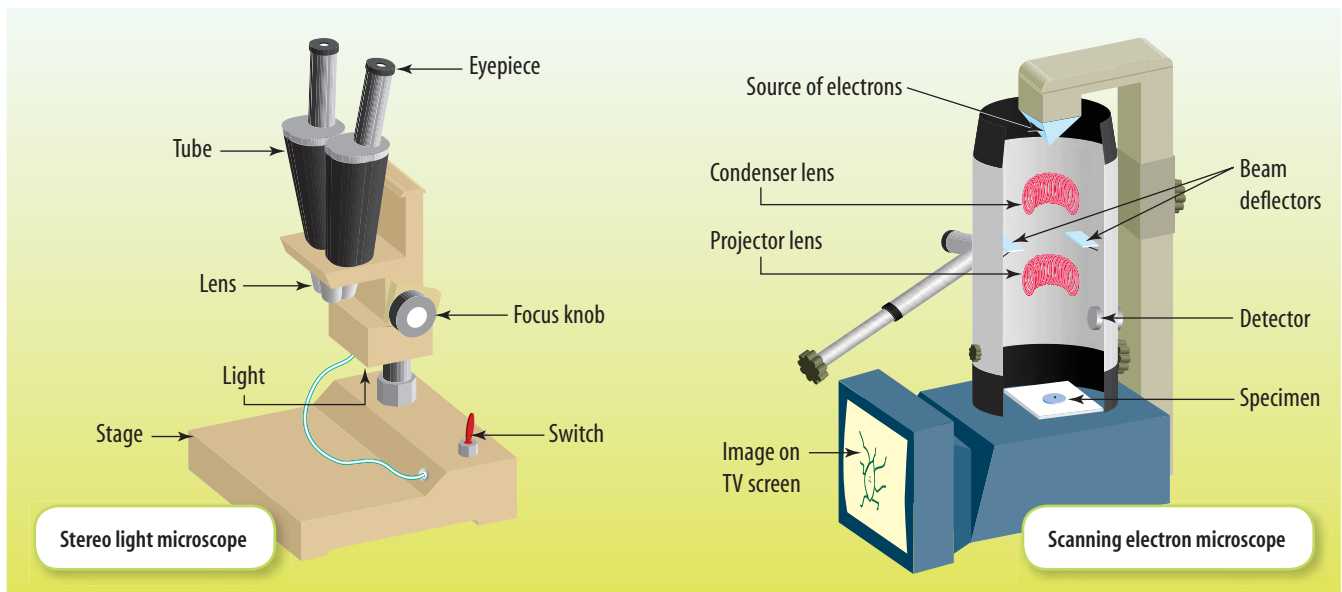
You may have light microscopes at your school. These may be either **monocular** (using one eye) or **binocular** (using two eyes). It is important that the specimen you observe using these is very thin, so that the light can pass through it. One type of binocular microscope, however, a **stereo** microscope, allows you to see the detail of much larger specimens. Stereo microscopes can be used to observe various objects including living organisms or parts of them.

Monocular light microscope

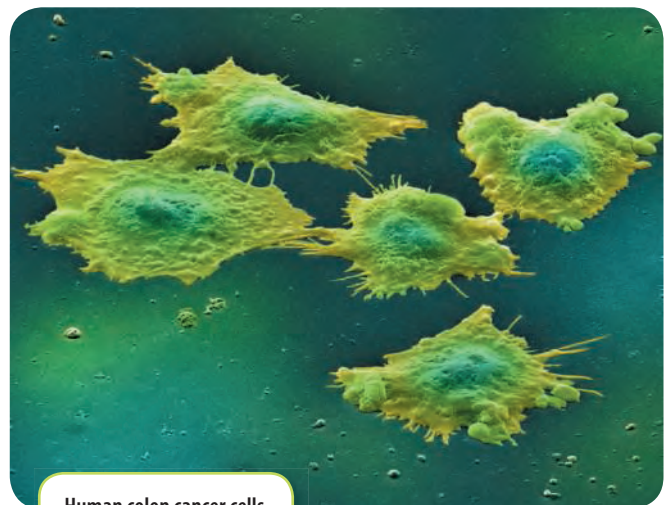


Some comparisons between light microscopes and electron microscopes

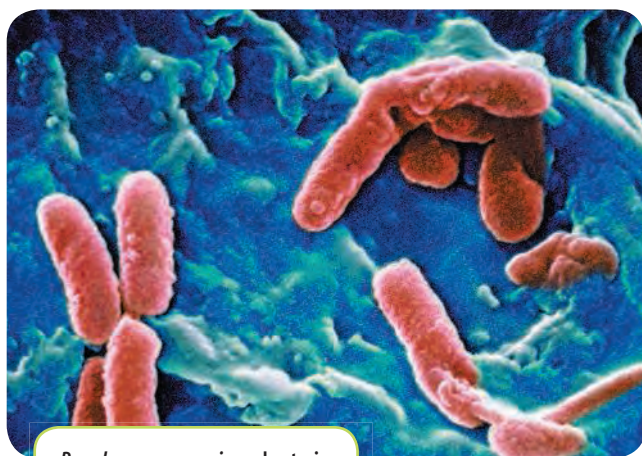
Type of microscope	Magnification (how many times bigger)	Resolution (how much detail can be seen)	Advantage(s)	Disadvantage(s)	Examples of detail that can be seen
Light microscope	Up to $\times 1500$	Up to about 500 times better than the human eye	Samples prepared quickly; coloured stains can be used; living cells can be viewed	Limited visible detail	Shapes of cells; some structures inside cells, e.g. nucleus and chloroplasts
Electron microscope	Up to $\times 1\,000\,000$	Up to about 5 million times better than the human eye	High magnification and resolution	Only dead sections can be viewed	All parts of cells; viruses



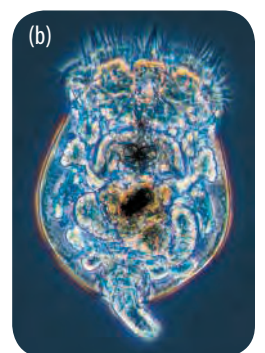
A flower bud (1 mm in diameter): the petals are shown in red, the anthers in blue and purple and the style and stigma in yellow.



Human colon cancer cells



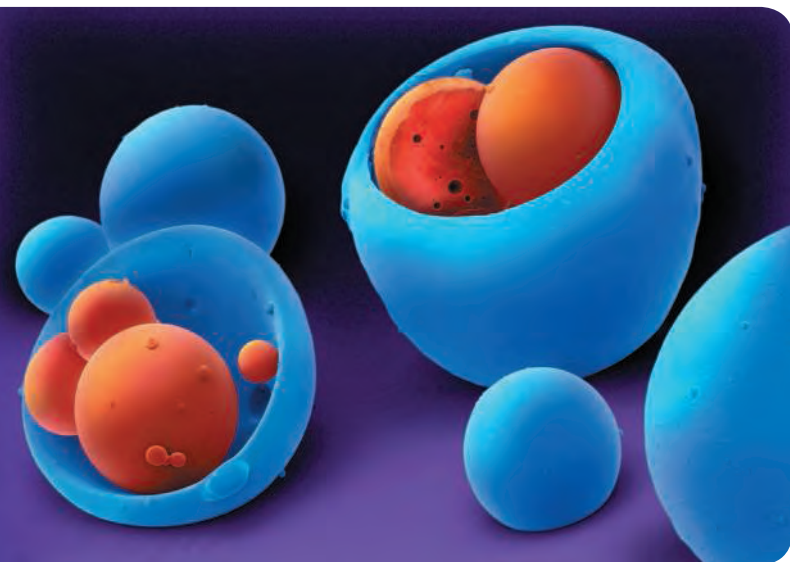
Pseudomonas aeruginosa bacteria



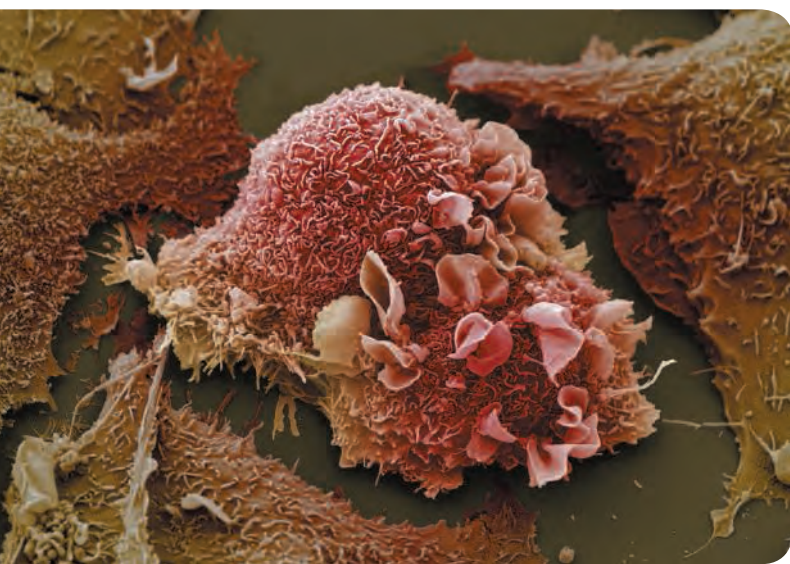
What's in your water?
These images show
zooplankton viewed
through a scanning
electron microscope.
(a) *Chaetognath*
(b) *Daphnia*
(c) A rotifer

Award-winning images

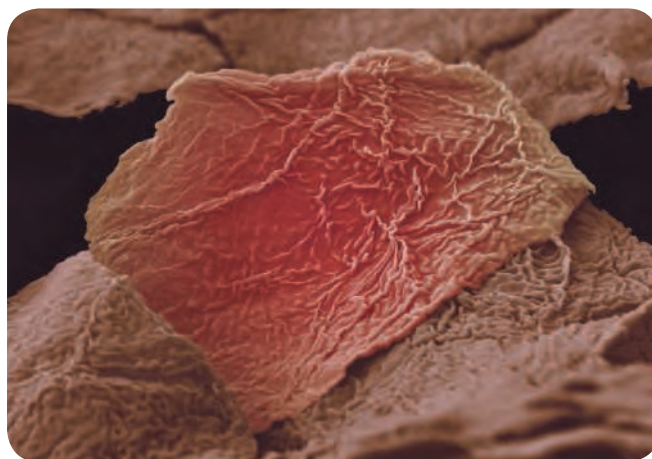
Microscopes are used not just to observe images of organisms, but also in many other areas of science. Some microscope images win awards recognising not just expertise but also creativity. For example, the Wellcome Trust, a charity that funds health research, presents awards for images that creatively explore the fields of medicine, health care and biology. The figures on this page show examples of some of the 2009 winners.



Electron micrograph of copolymers that can be used in drug delivery. The blue outer particle is the copolymer that encapsulates the inner orange particle loaded with the drug prednisolone, which is used to treat inflammatory bowel disease. (Image: Annie Cavanagh and Dave McCarthy)



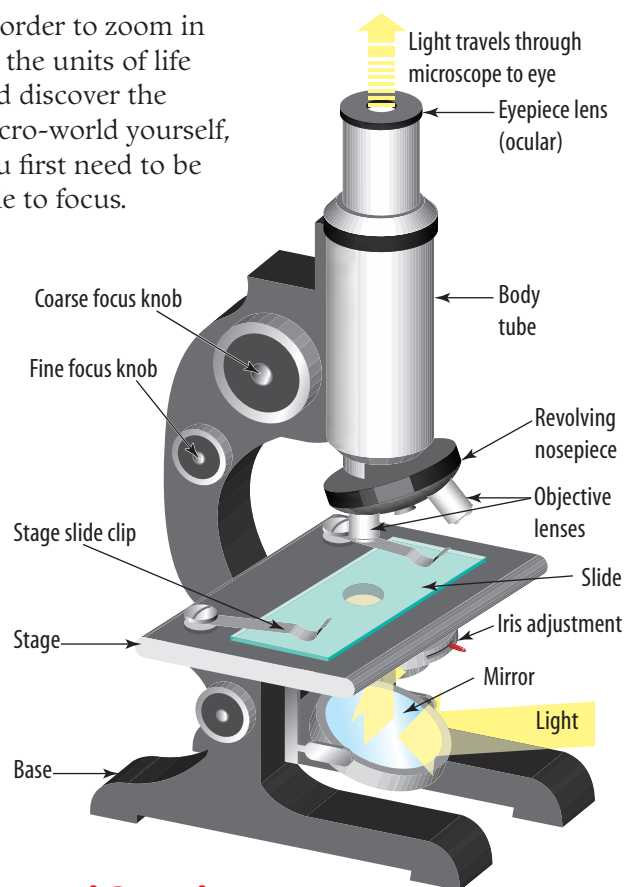
Electron micrograph of a single cell grown from a culture of lung cancer cells (Image: Anne Weston)



Electron micrograph of burn damaged skin cells; the burn was caused by the photographer, Anne Weston, spilling boiling soup on her hand. Anne Weston considers that this kind of curiosity is important in image-making as 'you never know what you are going to find'. (Image: Anne Weston)

Your turn as microbiologist

In order to zoom in on the units of life and discover the micro-world yourself, you first need to be able to focus.

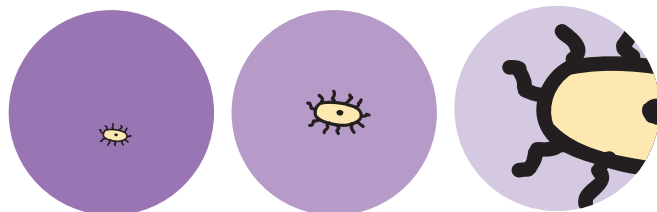


Magnification

The two lenses that determine the magnification of your microscope are the eyepiece lens and the objective lens. Each lens has a number on it that signifies its magnification. Multiplying the eyepiece

number by the objective lens number will give you the magnification of the microscope. For example:

- eyepiece: $\times 10$
- objective: $\times 40$
- magnification = $\times 400$.



Field of view 4 mm
(4000 μm)

Magnification $\times 40$

Field of view 1.6 mm
(1600 μm)

Magnification $\times 100$

Field of view 0.4 mm
(400 μm)

Magnification $\times 400$

As the field of view gets smaller, the magnification gets larger.

INQUIRY: INVESTIGATION 3.1

Getting into focus with an 'e'

KEY INQUIRY SKILL:

- processing and analysing data and information

Equipment:

1 cm square piece of newspaper containing the letter 'e'
monocular light microscope

microscope slide clear sticky tape

- Carefully stick the 1 cm square of newspaper onto a clean microscope slide using sticky tape.
- Using the microscope directions, get the paper into focus using the coarse focus knob and the lowest power objective lens (smallest magnification).
- Carefully move the slide until you have a letter 'e' in focus.
- Change to a higher level of magnification by rotating to a higher power objective lens.

DISCUSS AND EXPLAIN

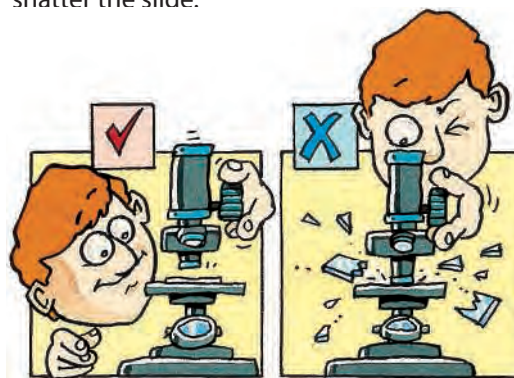
- 1 In which direction did the paper under the microscope move when you moved the slide
(a) towards you or (b) to the left?
- 2 What does the letter 'e' look like under the microscope? Draw a pencil sketch of what you see.
- 3 Record the magnification that you are using, and estimate how much of the viewed area is covered by the letter 'e' at this magnification.
- 4 Suggest what the letters 'P' and 'R' would look like under the microscope. Sketch your predictions, and then view examples of these under the microscope. Were your predictions correct?
- 5 Summarise all your results in a table, using descriptive diagrams.

Important points to remember when using a microscope

- 1 When lifting the microscope, put one hand on the body of the microscope and one hand under its base.
- 2 The microscope should be used on a flat surface and not too close to the edge.
- 3 Take care that the light intensity is not too high, or it might damage your eye.
- 4 When you have finished using the microscope, return the shortest objective lens into position.
- 5 Remove the slide, and ensure that the stage is clean.
- 6 Make sure that, when your microscope is not in use, it is always clean and carefully put away.

Using a microscope

- 1 Adjust your mirror so the appropriate amount of light passes through the hole in the stage.
- 2 Place the glass microscope slide (with a single hair specimen on top) onto the stage.
- 3 While watching from the side, use the coarse focus knob to lower the objective lens until it is just above the slide. Moving it down too far may shatter the slide.



How to focus your microscope — and how not to!

- 4 While looking through the eyepiece lens, carefully turn the coarse focus knob until the specimen is seen clearly.
- 5 Carefully use the fine focus knob so that you can see the details of your specimen as clearly as possible.
- 6 Sketch what you see.
- 7 Suggest by how many times your specimen has been magnified.

UNDERSTANDING AND INQUIRING

REMEMBER

- Construct Venn diagrams or double bubble maps to show the similarities and differences between:
 - a monocular microscope and a stereo microscope
 - a light microscope and an electron microscope.
- Other than just to observe images of organisms, how else can microscopes be used?
- Suggest why it is important not to have the light intensity setting too high on a light microscope.
- Explain the importance of watching from the side of the microscope while using the coarse focus knob.
- As the field of view of your microscope gets smaller, what happens to the magnification?

THINK AND REASON

- Use the 'field of view' diagrams on page 66 to answer the following questions. ($1000\ \mu\text{m} = 1\ \text{mm}$)
 - Estimate the length of the specimen shown in the diagram at $\times 40$, $\times 100$ and $\times 400$ magnification.
 - Describe the differences in your observations of the three different magnifications.

THINK

- When you are looking down the microscope, what happens when you move the microscope slide (a) to the left, (b) to the right, (c) towards you or (d) away from you?
- If you are using an eyepiece with a magnification of $\times 10$ and an objective lens of $\times 10$, how many times will the specimen viewed under the microscope be magnified?
- If a specimen is 1 mm in length, how big will it appear if it is magnified $\times 100$?
- If a specimen takes up the entire field of view at $\times 100$, how much of it will be seen at $\times 400$?
- Sketch a line diagram of your microscope and label as many of its parts as you can, using the diagram on page 65 to help you.
 - How does your microscope differ from the one shown on page 65?
 - Suggest the advantages and disadvantages of the differences.
- Copy and complete the table below.

Ocular lens (eyepiece)	Objective lens	Magnification
$\times 5$	$\times 5$	$\times 25$
$\times 5$	$\times 10$	
$\times 10$		$\times 100$
	$\times 40$	$\times 400$

CREATE

- Investigate developments in our understanding of cells.
 - Suggest how this knowledge has influenced areas in health or medicine.
- Design and make a poster which shows either how a microscope should be used or what happens when you use it the wrong way.
- Make a model of a microscope.
- Design a microscope of the future. Prepare an instruction booklet and develop exciting promotional material.

INVESTIGATE

- Draw up a table that summarises the functions of the different parts of the microscope.
 - Construct a crossword that could be used to help students learn this information.
 - Share copies of your crossword with others in the class to try to find the solutions, and attempt to solve the crosswords of others in your class.
 - In a team, act out the parts and functions of a microscope.
- Observe 10 different specimens (for example, hair, fingernail, pencil, insect, plant) under a stereo microscope. Sketch or describe what you see. Comment on the similarities and differences observed, and on any interesting findings.
- Find out how specimens are prepared for examination under an electron microscope. Construct a PMI chart on your findings.
- Prepare a report on the activities of scientists involved in these studies of cells: (a) cytology, (b) biochemistry, (c) microbiology, (d) histology.

eBook plus

- Visit the **Wellcome Trust award winners** weblink in your eBookPLUS to find out more about the award winners and listen to Anne Weston talk about her work as an electron microscopist.
- Test your knowledge of the functions of different parts of a microscope by completing the **Microscope parts** interactivity in your eBookPLUS. **int-0205**
- Use the **Electron microscope** weblink in your eBookPLUS to view some electron micrographs. Analyse how the images produced by an electron microscope are different from those produced by a light microscope.

work
sheet

3.2 In focus

Form and function: Cell make-up

Same building blocks, but different structures?

Similar, but different

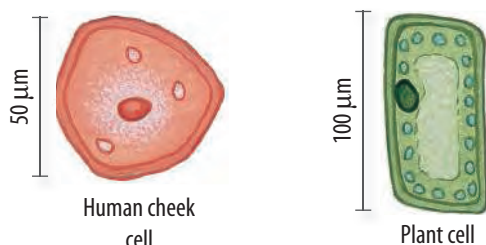
Cells are the building blocks that make up all living things. Organisms may be made up of one cell (**unicellular**) or many cells (**multicellular**). These cells contain small structures called organelles that have particular jobs within the cell and function together to keep the organism alive.

Cells can be divided on the basis of the presence and absence of particular organelles and other structural differences. Organisms can be classified by the different types of cells they are made up of.

How big is small?

The size of cells may vary between organisms and within a multicellular organism. Most cells are too small to be seen without a microscope. Cells need to be very small because they have to be able to quickly take in substances they need and remove wastes and other substances. The bigger a cell is, the longer this process would take.

Very small units of measurement are used to describe the size of cells. The most commonly used unit is the **micrometre** (μm). One micrometre equals one millionth ($1/1\,000\,000$) of a metre or one thousandth ($1/1000$) of a millimetre. Check out your ruler to get an idea of how small this is! Most cells are in the range of $1\,\mu\text{m}$ (bacteria) to $100\,\mu\text{m}$ (plant cells).



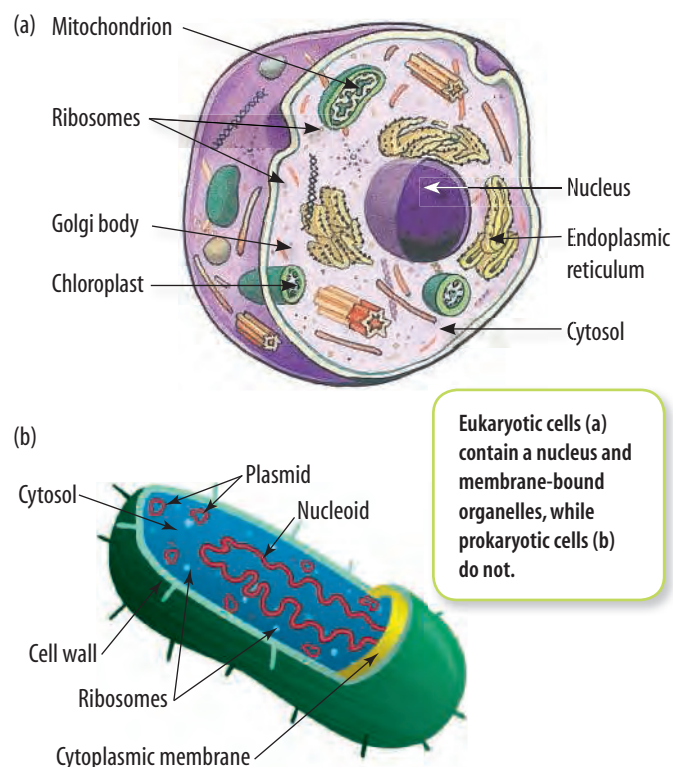
Advances in technology are creating an increased need for the use of the **nanometre** (nm) as a unit. One nanometre (nm) equals 1 billionth ($1/1\,000\,000\,000$) of a metre. Investigating the organelles within cells and the molecules they are reacting with requires this level of measurement.

Nanotechnology is a rapidly developing field that includes studying and investigating cells at this 'nanolevel'. While it requires lots of creative, exciting and futuristic 'what if' thinking, it also requires an understanding of the basics of information and ideas currently known.

Have it or not?

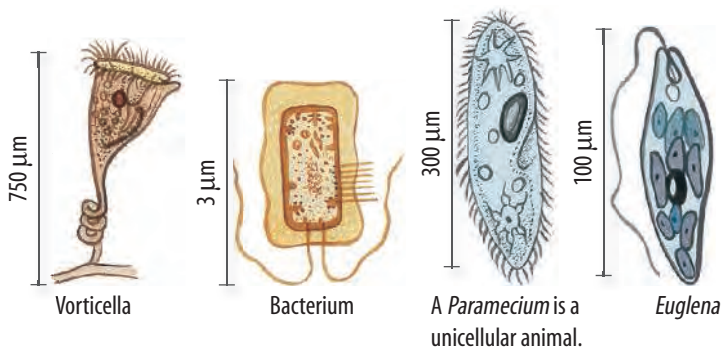
Prokaryotes such as bacteria were the first type of organism to appear on Earth. The key difference between the prokaryotes and all other kingdoms is that members of this group do not contain a nucleus or other membrane-bound organelles. The word prokaryote comes from the Greek terms *pro*, meaning 'before', and *karyon*, meaning 'nut, kernel or fruit stone', referring to the cell nucleus.

Eukaryotic organisms made up of eukaryotic cells appeared on Earth billions of years later. As *eu* is the Greek term meaning 'good', **eukaryote** can be translated as 'true nucleus'. Members of the four kingdoms Animalia, Plantae, Fungi and Protocista are eukaryotes and are made up of cells containing a nucleus and other membrane-bound organelles.



What do we share?

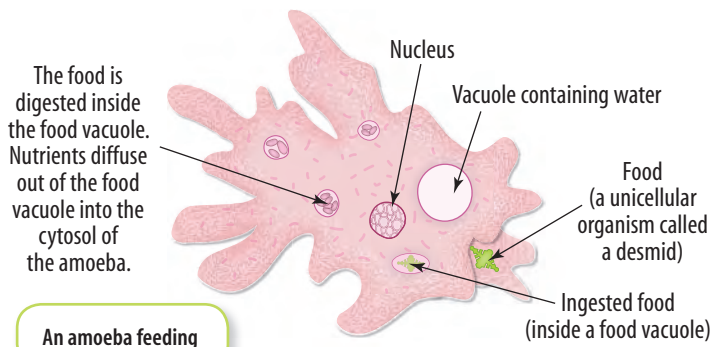
What most cells have in common is that they are made up of a **cell membrane** containing a fluid called **cytosol** and small structures called **ribosomes**. The collective term used to describe the cytosol and all the organelles suspended within it is **cytoplasm**. The hundreds of chemical reactions essential for life that occur within the cytoplasm are referred to as the cell's **metabolism**. The ribosomes are where proteins such as enzymes are made, which regulate the many chemical reactions important to life. The cell membrane regulates the movement of substances into and out of the cell. This enables the delivery of nutrients and substances essential for these reactions, and the removal of wastes.



All on my own

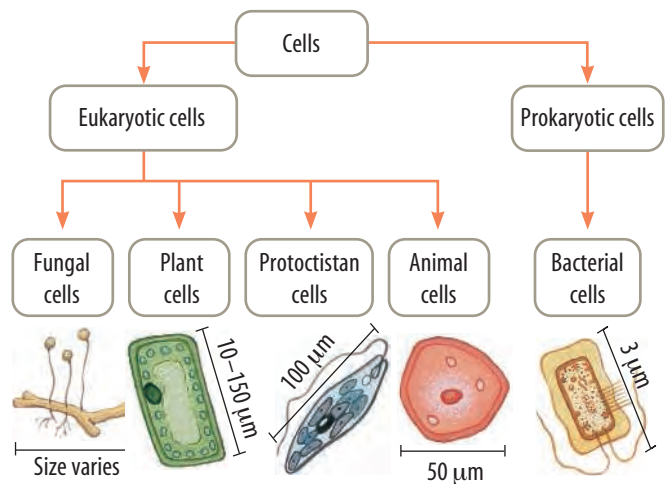
Unicellular organisms such as bacteria, *Amoeba*, *Euglena* and *Paramecium* need to carry out all the required processes themselves. They even reproduce themselves by dividing into two. This process is called **binary fission**.

To live long enough to reproduce, unicellular organisms need to be able to function on their own. They need to be able to obtain their nutrients and remove their wastes. The solution to this requirement has resulted in the wonderful diversity of unicellular organisms that are alive on our planet today or have lived in our planet's history.



Five kingdoms?

Living things can be divided into five kingdoms — **Animalia** (animals), **Plantae** (plants), **Fungi** (for example, mushrooms), **Protocista** (also called Protista) and **Prokaryotae** (also called Monera). While this system provides an opportunity to classify organisms into these groups, information from currently developing technologies means that it will not be long until a new extended classification system evolves.



A key characteristic used to classify organisms into kingdoms is the structure of their cells.



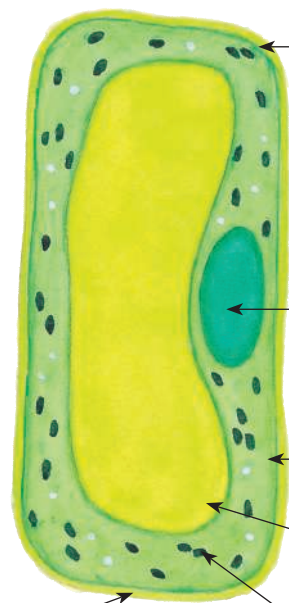
WHAT DOES IT MEAN?

The prefix *uni-* comes from the Latin term meaning 'one'. The prefix *multi-* comes from the Latin term meaning 'many'.

Specialist workers

Multicellular organisms are made up of many different types of cells that have different jobs to do. Each of these cells has a particular structure so that it is able to do the job it is specialised for. This may include the presence and number of particular organelles or additional external structures to assist with movement (such as flagella or cilia).

Plant cell



Cell wall

The tough covering around plant cells is the cell wall. It gives plant cells strength and holds them in shape. Plant cell walls are made of a substance called **cellulose**. Water and dissolved substances can pass through the cell wall. Animal cells do not have a cell wall.

Cell membrane

The thin layer that encloses the cytosol is the cell membrane. It keeps the cell together and gives it its shape. Some substances, such as water and oxygen, can pass through the cell membrane but other substances cannot. The cell membrane controls what enters and leaves the cell.

Nucleus

The nucleus is the control centre of the cell. It contains DNA in the form of chromosomes and it controls what the cell does and when.

Cytosol

The jelly-like substance inside cells is the cytosol. It contains many important substances, such as glucose, that are needed for chemical reactions that occur inside cells.

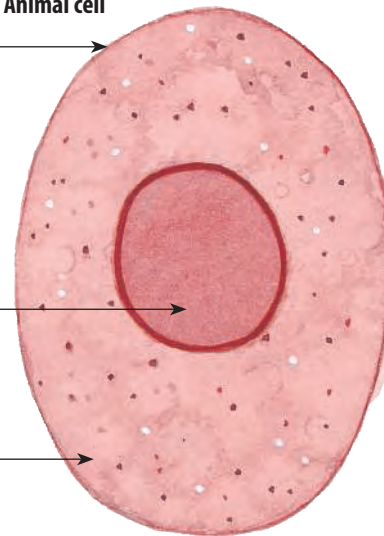
Chloroplasts

Chloroplasts are the oval-shaped organelles found only in plant cells. Chloroplasts contain a green substance called chlorophyll. Chloroplasts use energy from the sun to make food. Not all plant cells contain chloroplasts. They are found only in leaf and stem cells.

Microfactories

Mitochondria and **chloroplasts** are examples of membrane-bound organelles found in eukaryotic cells. While all eukaryotic cells contain mitochondria, because they are all involved in **cellular respiration**, only those involved in **photosynthesis** (such as those in plant leaves) contain chloroplasts. Chloroplasts contain the green pigment **chlorophyll**. This pigment is used to trap light energy so that it can be converted into chemical energy and used by the cells.

Animal cell



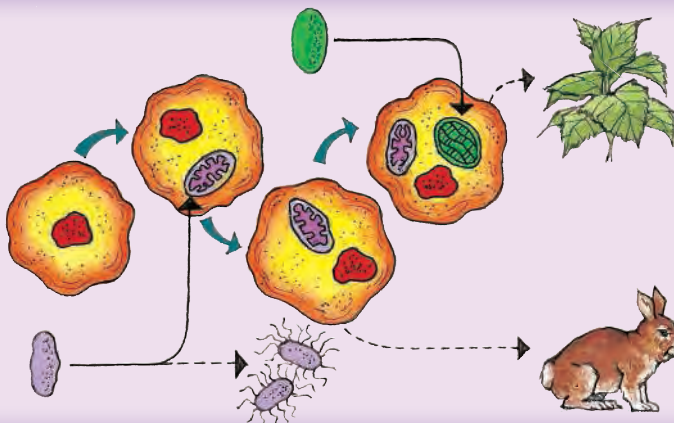
Vacuole

The vacuole is an organelle used to store water and dissolved substances. Vacuoles can look empty, like an air bubble. Plant cells usually have one large vacuole. The mixture inside a plant's vacuoles is called **cell sap**. The red, blue and violet colours that you often see in plant leaves and flowers are due to the substances stored in vacuoles. Most animal cells don't have vacuoles.

HOW ABOUT THAT!

There is a theory called the endosymbiotic theory that suggests that mitochondria and chloroplasts were once prokaryotic organisms. This theory suggests that, at some time in the past, these organisms were engulfed by another cell and over time they evolved to depend on each other.

The origin of the eukaryotic cell? Some scientists are also suggesting that our nucleus may have come from a giant viral ancestor.



Some differences in the basic cell design in the five kingdoms

Characteristic	Kingdom				
	Animalia (animals: e.g. lizards, fish, spiders, earthworms, sponges)	Fungi (e.g. yeasts, moulds, mushrooms, toadstools)	Plantae (plants: e.g. ferns, mosses, conifers, flowering plants)	Protocista (e.g. algae, protozoans)	Prokaryotae (bacteria and cyanobacteria)
Number of cells	Multicellular	Usually multicellular but some unicellular	Most multicellular	Unicellular or multicellular	Unicellular
Nucleus	Present	Present	Present	Present	Absent
Cell wall	Absent	Present	Present	Present in some	Present
Large vacuole	Absent	Absent	Present	Present in some	Absent
Chloroplasts	Absent	Absent	Present in leaf and stem cells	Present in some	Absent (but chlorophyll may be present in some)

UNDERSTANDING AND INQUIRING

REMEMBER

- 1 What do all living things have in common?
- 2 Why is the nucleus important to the cell?
- 3 State the names of the five kingdoms and use the table above to determine which kingdoms contain organisms that are eukaryotes.
- 4 What is the purpose of the cell membrane?
- 5 Identify where enzymes are made in a cell and state why are they important.
- 6 Construct a triple Venn diagram (three overlapping circles) to compare plants, animals and fungi.
- 7 Suggest why organisms are divided into five kingdoms rather than just the plant and animal kingdoms.

THINK AND REASON

Use the table above to answer the following questions.

- 8 In which kingdom(s) do the cells of an organism:
 - (a) not have a cell wall, large vacuole or chloroplasts?
 - (b) have a cell wall, large vacuole and chloroplasts?
 - (c) have a cell wall, but no large vacuole or chloroplasts?
 - (d) have a cell wall and a nucleus without a membrane around it?
- 9 List two examples of each of the five kingdoms.

Use the diagrams of cells on page 69 to complete activities 10 and 11.

- 10 Construct a table with the following headings: 'Name of organism' or 'Type of cell', and 'Cell size (μm)'.
- 11 Show the sizes of the cells on a graph, with the horizontal axis representing the type of cell and the vertical axis representing the size of cell. Sketch an outline of each cell as accurately as you can in the correct position on the graph. Which cell is the biggest and which is the smallest?

- 12 Fungi were once classified as plants. On the basis of their cells, suggest why they are no longer classified in this group.

CREATE

- 13 Make a labelled model of a cell from one of the kingdoms. Use materials available at home, such as drink bottles, egg cartons, cottonwool, wool, cotton or dry foods.

INVESTIGATE AND CREATE

- 14 What does the endosymbiotic theory suggest? Formulate questions to ask about it. Research and report on your questions.
- 15 Research and report on:
 - (a) examples of prokaryotic cells and interesting survival strategies
 - (b) mitochondrial DNA and haplogroups.
- 16 Research two of the organelles or cells listed below. Create a play and construct puppet models for your characters. Present your play to the class.
 - Nucleus
 - Mitochondrion
 - Chloroplast
 - Prokaryotic cell
 - Protocistan cell
 - Animal cell
 - Plant cell
- 17 Investigate the different types of cells and create your own picture book about them using the following steps.
 - (a) Construct a matrix table (see page 340) to show the differences between the cells of the different kingdoms.
 - (b) Construct a storyboard for a picture book about them.
 - (c) Create the picture book.

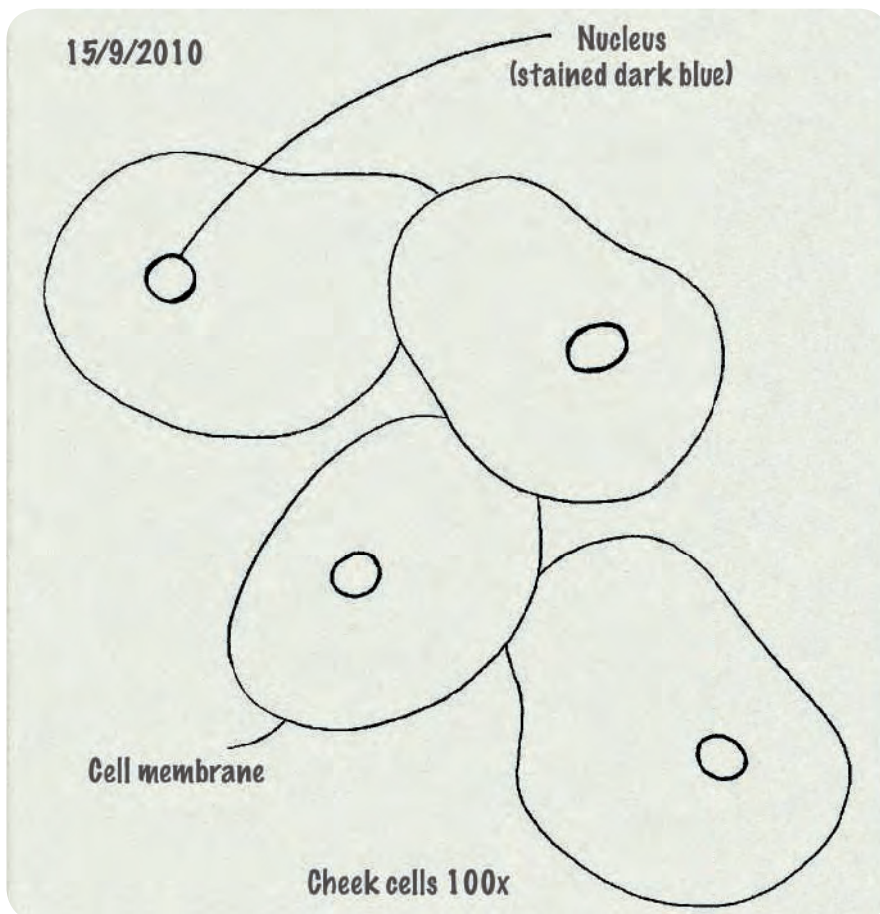
Zooming in on life

Now that you are in focus, let's zoom in on life.

Sketching what you see under the microscope

SOME POINTS TO REMEMBER

- 1 Use a sharp pencil.
- 2 Draw only the lines that you see (no shading or colouring).
- 3 Your diagrams should take up about a third to half a page each.
- 4 Record the magnification next to each diagram.
- 5 State the name of the specimen and the date of observation.
- 6 A written description is also often of considerable value.
- 7 When you are viewing many cells at one time, it is often useful to select and draw only two or three representative cells for each observation.



An example of a sketch of a microscope specimen

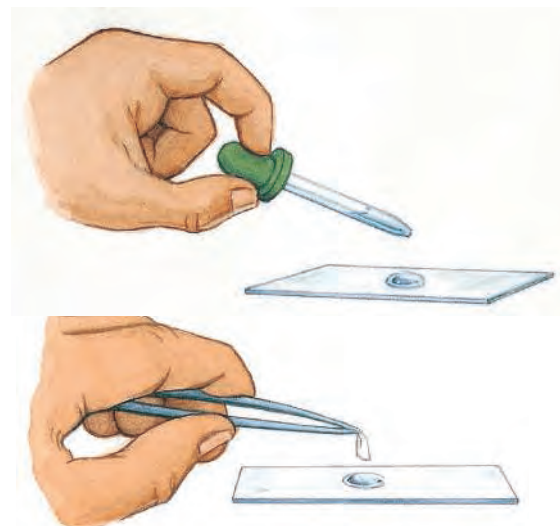
Preparing a specimen

Light microscopes function by allowing light to pass through the specimen to reach your eye. If the specimen is too thick, the object cannot be seen as clearly or may not be seen at all.

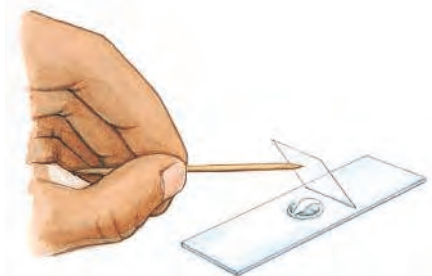
Careful peeling, scraping, slicing or squashing techniques can be used to obtain thin specimens of the object to be studied.

PREPARING A WET MOUNT SLIDE

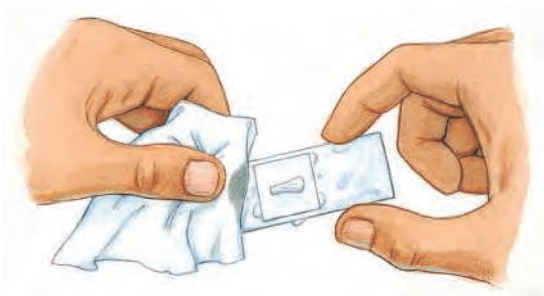
- 1 Place a drop of pond water on a clean glass slide. Place the specimen on top.



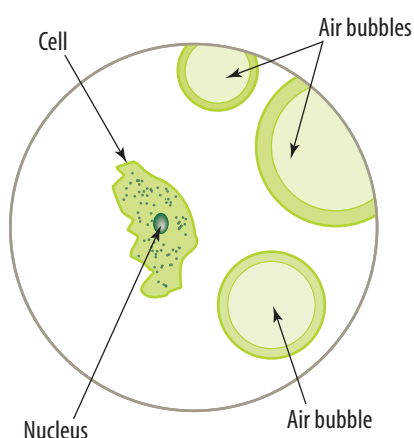
- 2 Gently place a coverslip (a very thin piece of glass that holds the specimen in place) on the pond water by putting one edge down first. Use a toothpick to lower the coverslip to avoid air bubbles.



- 3 Use a tissue or blotting paper to soak up any water that has escaped.



- 4 Incorrect placing of the coverslip can result in air bubbles.



STAINING A SPECIMEN

Many objects are colourless when viewed down the microscope, so specimens are often stained to make them easier to see. Methylene blue, iodine and eosin are some examples of stains often used.

Each stain reacts with different chemicals in the specimen. For example, iodine stains starch a blue-black colour.

Take care when using these stains, because they can stain you as well!

- 1 Add a few drops of iodine to a very small amount of squashed banana on a microscope slide.
- 2 Gently place a coverslip on top as shown in the diagram on page 72.

INQUIRY: INVESTIGATION 3.2

All in one cell!

KEY INQUIRY SKILLS:

- processing and analysing data and information
- planning and conducting

Equipment:

light microscope

living specimens: Paramecium, Euglena, Amoeba

- Use a light microscope to prepare a wet mount of the specimens.
- Draw sketches of what you see, identifying any cell components. Remember to include the magnification used.
- Construct a matrix to show similarities and differences between the specimens.

DISCUSS AND EXPLAIN

Which kingdom do you think each specimen may belong to? Why?

INQUIRY: INVESTIGATION 3.3

Kitchen and wardrobe detective

KEY INQUIRY SKILLS:

- questioning and predicting
- planning and conducting

Equipment:

light microscope and microscope slides

spatula

selection of white powders (e.g. flour, salt, sugar, baking soda)

ground, instant and freeze-dried coffee

different brands or types of spices and leaf tea

fibres (e.g. cotton, linen, silk, wool, polyester, nylon, various combinations of these)

hairs (of members of your class or family, or of animals)

- Examine a variety of the substances and materials listed above under the microscope.
- Try to determine the contents of an 'unknown mixture' that contains three or four of the substances and materials previously examined.

DISCUSS AND EXPLAIN

- 1 Draw sketches of what you see, and record comments or descriptions next to each.
- 2 Estimate the size of the specimens that you see.
- 3 Summarise your results in a table.
- 4 Describe how your specimens differed.

INQUIRY: INVESTIGATION 3.4

Pond water

KEY INQUIRY SKILL:

- processing and analysing data and information

Equipment:

light microscope pond water
microscope slides pipette
coverslips

- Prepare a wet mount of the pond water on a microscope slide.
- Examine the pond water under the microscope.
- Draw sketches and describe what you see.

INQUIRY: INVESTIGATION 3.5

Peel or squash and stain

KEY INQUIRY SKILL:

- processing and analysing data and information

Equipment:

light microscope
microscope slides
coverslips
pipette
onion, banana
water, methylene blue, iodine

- Peel some onion skin and carefully place on a slide with a drop of methylene blue.
- Cover carefully with a coverslip.
- Prepare a banana squash on a slide and add a drop of iodine.
- Cover with a coverslip.



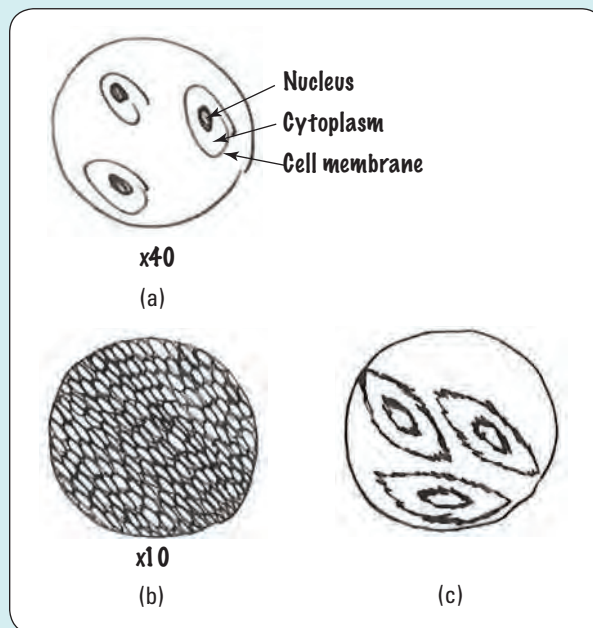
DISCUSS AND EXPLAIN

- Record what you see under the microscope for each slide.
- Describe the similarities and differences between your observations of the banana and the onion cells.

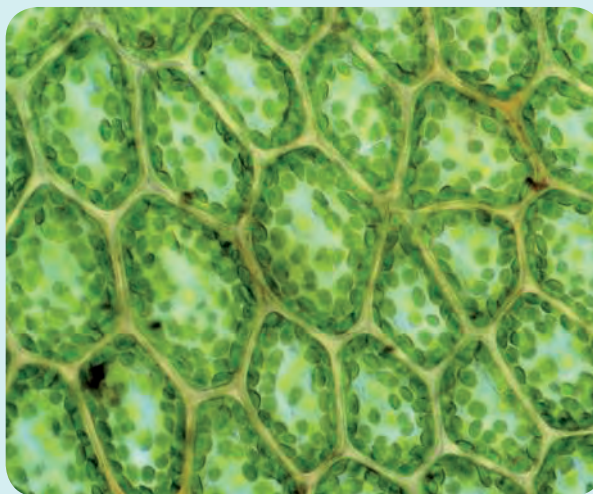
UNDERSTANDING AND INQUIRING

THINK, DISCUSS AND INVESTIGATE

- Carefully observe the student sketches shown below. For each diagram, list what is wrong with it and suggest how it could be improved.



- Carefully observe the figure of plant cells below and construct a sketch of one of the cells.



CREATE

- Design a poster that shows others how to prepare a variety of specimens to be viewed under a microscope.

work
sheet

→ 3.3 Preparing a stained wet mount

Focus on animal cells

What do the cells inside your body look like? Why aren't they all the same size and shape?

In all shapes and sizes

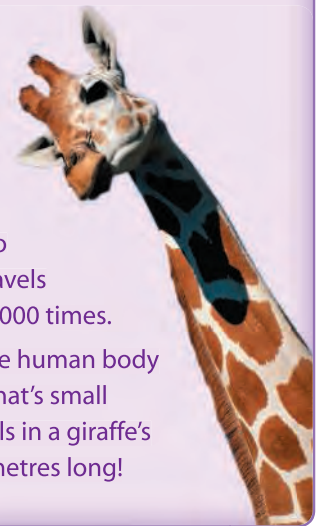
Cells within an organism may differ in their shape and size. This difference may be due to the particular jobs or functions that the cells carry out within the organism. The human body is made up of more than 20 different types of cells, with each type suited to a particular function.

Nerve cells develop long, thin fibres that quickly carry messages from one cell to another. Cells lining the trachea have hair-like cilia that move fluid and dust particles out of the lungs. Muscle cells contain fibres that contract and relax, and the human sperm cell has a tail or flagellum that helps it swim to the egg cell.

HOW ABOUT THAT!

Did you know these facts about human cells?

- Hair and nails are made of dead cells, and because they are not fed by blood or nerves you can cut them without it hurting.
- A human baby grows from one cell to 2000 million cells in just nine months.
- Red blood cells live for one to four months and each cell travels around your body up to 172 000 times.
- Some of the nerve cells in the human body can be one metre long. But that's small compared with the nerve cells in a giraffe's neck. They are two to three metres long!



INQUIRY: INVESTIGATION 3.6

Animal cells — what's the difference?

KEY INQUIRY SKILL:

- processing and analysing data and information

Equipment:

light microscope

prepared animal slides:

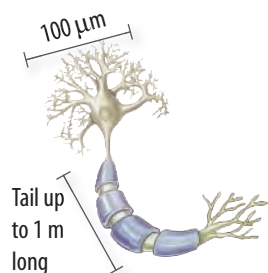
blood cells, muscle cells, cheek cells, nerve cells

- Construct a table like the one below, making it large enough for all of your results.
- Use a microscope to observe the prepared slides, recording your observations in the table as you make them.
- Prepare a summary table that describes the similarities and differences observed between the different cells examined.

DISCUSS AND EXPLAIN

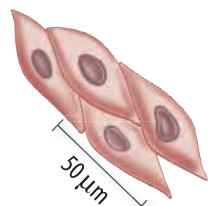
- 1 Which features did the animal cells have in common?
- 2 In what ways did the animal cells differ from each other?
- 3 Why are there some features that all cells possess?
- 4 Find out the functions of the different types of cells examined.
- 5 Suggest how the shape or size of the cells may assist the cell in doing its job.
- 6 Suggest reasons for some of the differences observed between the cells.

Source of specimen	Type of specimen	Sketch of specimen	Description of specimen
Animal	Cheek cells	[Allow as much space as you can; draw only 2 or 3 cells, in pencil, and include magnification and estimated size.]	[Describe in words what the specimen looked like.]



Nerve cells

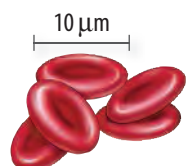
Nerve cells are very long and have a star shape at one end. The long shape of nerve cells helps them detect and send electrical messages through the body at the speed of a Formula 1 racing car. There are nerve cells all over your body. They allow you to detect touch, smell, taste, sound, light and pain.



Muscle cells

Muscle cells are long and elastic. Long thin cells can slide further over each other to allow you to move. There are

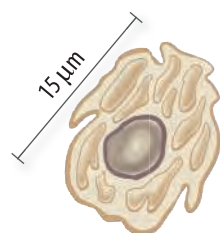
different types of muscle cells. The walls of your blood vessels and parts of your digestive system have 'smooth muscle' cells. The muscles that are joined to your bones are called 'skeletal muscles'. Skeletal muscles work in pairs — one muscle contracts (shortens) and pulls the bone in one direction while the other muscle relaxes.



Red blood cells

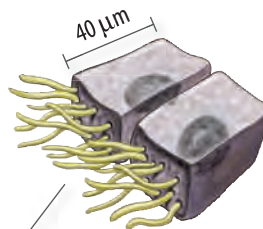
Red blood cells carry oxygen around the body. Their small size allows them to move

easily through blood vessels. The nucleus in a red blood cell dies soon after the cell is made. Without a nucleus, red blood cells live for only a few weeks. The body keeps making new blood cells to replace those that have died. Red blood cells are made in bone marrow at the rate of 17 million cells per minute! This is why most people can donate some of their blood to the Red Cross without harm. White blood cells, which are larger than red blood cells, are also made in the bone marrow. Their job is to rid the body of disease-causing organisms and foreign material.



Bone cells

Minerals such as calcium surround your bone cells. The minerals help make bone cells hard and strong. Bone cells need to be hard so that they can keep you upright.



Lung epithelial cells

The cells that line your nose, windpipe and lungs are a type of lining cell. They have hair-like tips called cilia. These cells help protect you

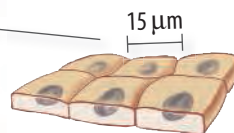
from getting down your windpipe. The cilia can also move these substances away from your lungs. You remove some of these unwanted substances whenever you sneeze, cough or blow your nose.



Adipose tissue cells

Some cells store fat. Fat stores a lot of energy for cells to use later. Round shapes are good for holding a lot of material in a small space.

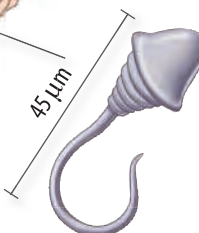
Fat cells are mostly found underneath your skin, especially in the chest, waist and buttocks.



Skin cells

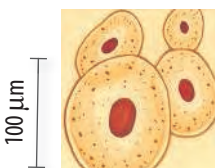
Special cells line the outside surfaces of your body. These are the cells that form

your skin. These cells have a flattened shape so they can better cover and protect your body.



Sperm cells

Sperm cells have long tails that help them swim towards egg cells. Only males have sperm cells.



Egg cells

Egg cells are some of the largest cells in a human body. Their large round shape helps them store plenty of food. Only females have egg cells. When a sperm cell moves into an egg cell, the egg cell is fertilised.

UNDERSTANDING AND INQUIRING

REMEMBER

- 1 Match the types of cells with their functions.

Type of cell	Function
Muscle	Outside covering for protection
Skin	contracts and relaxes
Red blood	Carries messages from cell to cell
Nerve	Carries oxygen from lungs to other parts

- 2 Which features do most cells have in common?
 3 Describe some ways in which cells may differ.
 4 Suggest why the cells in a multicellular organism are not all the same. Give examples in your answer.

THINK AND REASON

- 5 (a) Use the illustrations on the opposite page to find the size of the following different types of animal cells.
 (i) Adipose tissue cell (v) Human blood cell
 (ii) Epithelium cell (vi) Smooth muscle cell
 (iii) Cheek cell (vii) Sperm cell
 (iv) Nerve cell
 (b) Summarise your data in a table.
 (c) Determine the average size of an animal cell.
 (d) Use a bar graph to plot the sizes of the different types of cells.
 (e) Comment on the differences between the cells.

THINK

- 6 Copy and complete the table below.

Cell parts and functions in animal cells

Part	Function
Cytoplasm	
Nucleus	
Cell membrane	

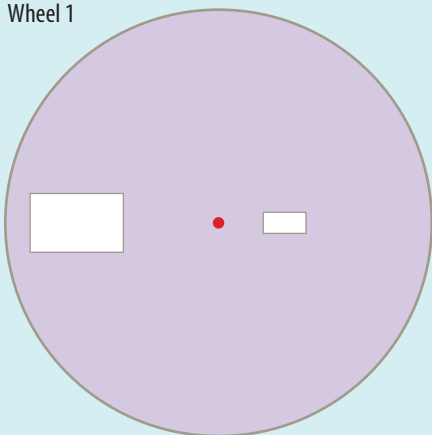
INVESTIGATE, IMAGINE AND CREATE

- 7 Find out more about a particular type of cell and use this information to write a play, poem or story about a day in the life of this type of cell.
 8 Construct a model of a nerve cell using food as your construction material.

eBook plus

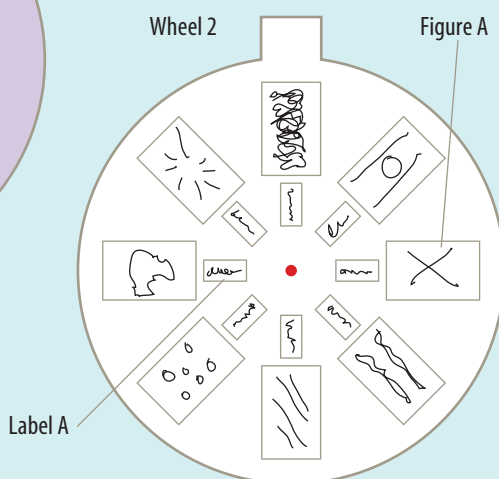
- 9 Match each cell with its purpose in the body by completing the **Cell jobs** interactivity in your eBookPLUS. **int-0206**
 10 Using your own research and the information on page 76, construct a 'peep through' learning wheel that shows the structure and function of the different types of animal cells. Instructions for making a 'peep through' learning wheel are given below.

Wheel 1



How to make a 'peep through' learning wheel

Wheel 2

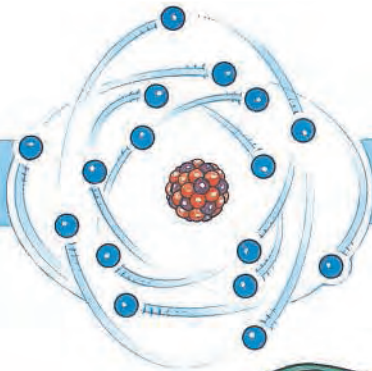


- a. On an A4 piece of white paper or card draw two circles, one with a 'tab' (wheel 2) and one without (wheel 1).
 b. Cut out the two rectangular box areas as shown on wheel 1.
 c. Draw in the large and the small rectangles as shown on wheel 2.
 d. Write the animal cell types in the small boxes on wheel 2. Sketch matching diagrams of examples of these cell types in the corresponding large box opposite.
 e. Attach the two wheels, with wheel 1 on top, using a paper fastener.
 f. Rotate your wheel to view examples of types of animal cells.

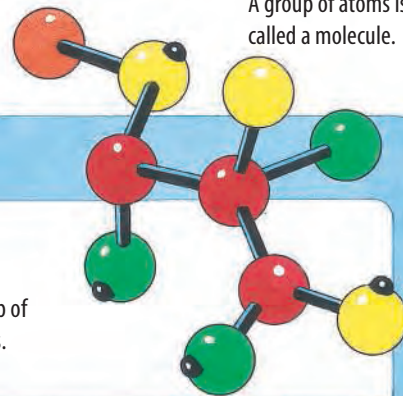
Animal cells — made to order?

Like all matter in the universe, you are made up of atoms. Collections of atoms make up **molecules**, molecules make up organelles, which make up cells, which make up tissues, which make up organs, which make up systems, which make up you.

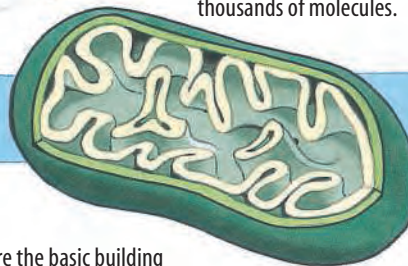
All matter in the universe is made up of atoms.



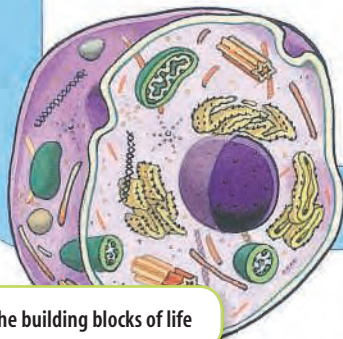
A group of atoms is called a molecule.



An organelle is made up of thousands of molecules.



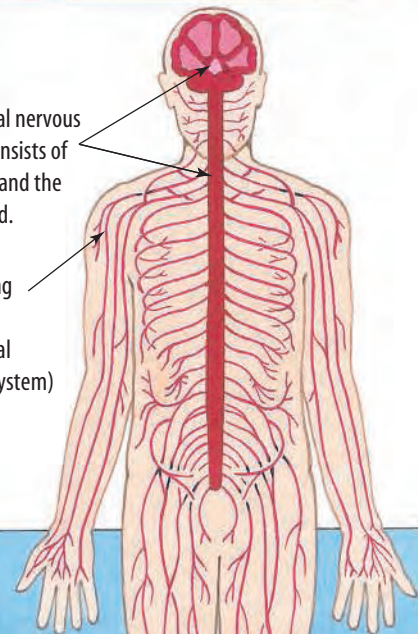
Cells are the basic building blocks of all living things. They contain different types of organelles.



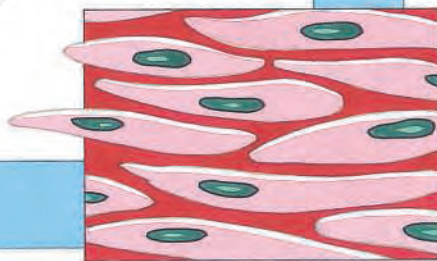
The building blocks of life

The central nervous system consists of the brain and the spinal cord.

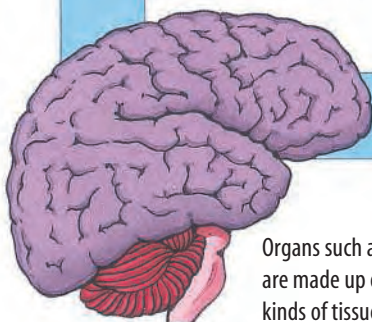
Connecting nerves (peripheral nervous system)



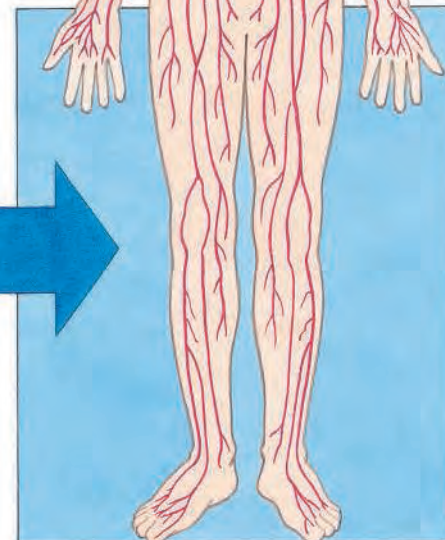
Groups of cells that do a specialised job are called tissues. The smooth muscle in your body is a tissue.



Organs such as the human brain are made up of different kinds of tissue.



Several organs working together make up a system, such as the central nervous system and peripheral nervous system.



Organelles

Thousands or millions of molecules make up organelles. Each organelle has a particular job to do. Mitochondria, for example, are organelles in which the chemical energy in glucose is transformed into energy that our cells can use.

Cells

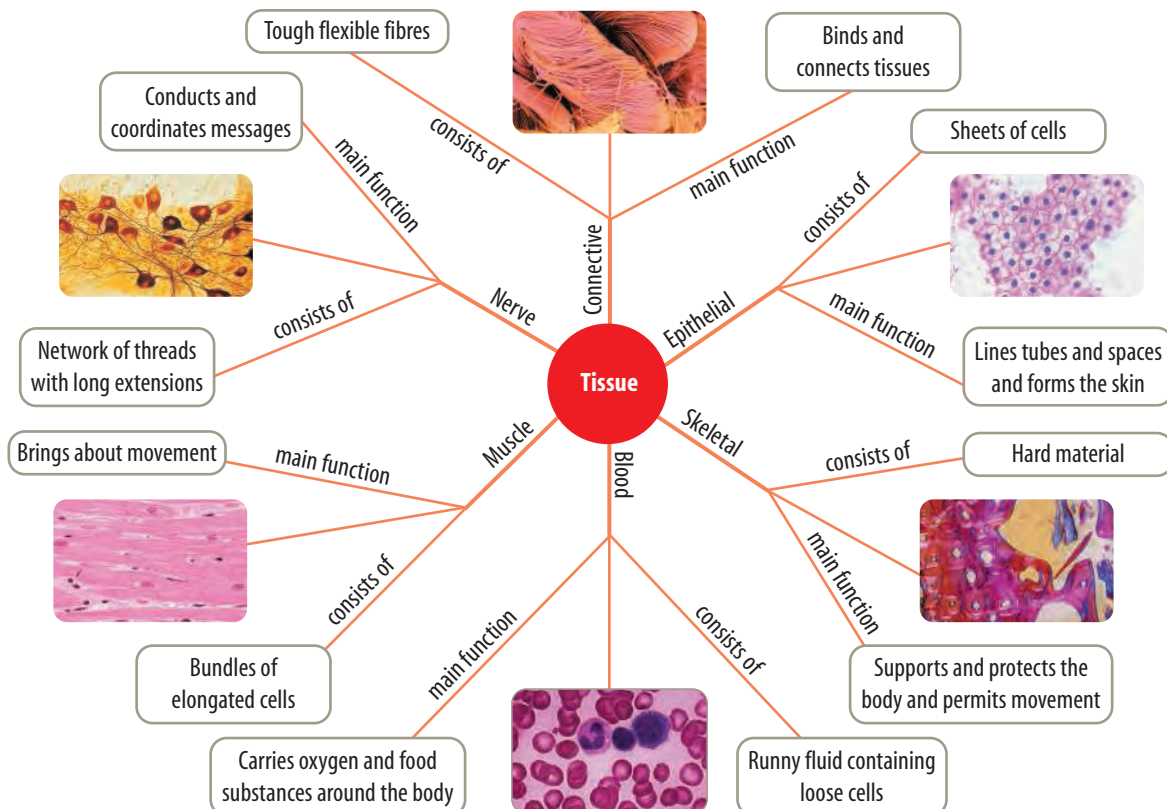
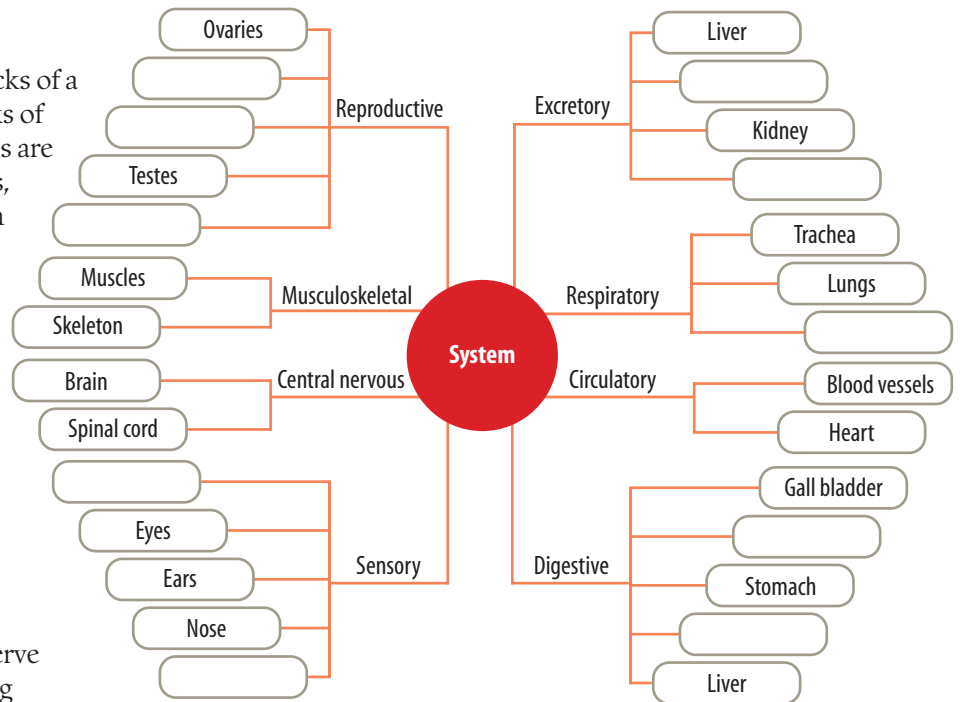
Just as bricks are the basic building blocks of a house, cells are the basic building blocks of all living things. Multicellular organisms are made up of many different types of cells, each with different jobs to do. Although these cells may have similar basic structures, they may differ in size, in shape and in the number and types of organelles that they contain.

Tissues

Groups of similar cells that carry out a specialised job are called **tissues**. Muscle tissue contains cells with many mitochondria so that the energy requirements of the tissue can be met. Nerve tissue consists of a network of nerve cells with extensions to assist in carrying messages throughout your body.

Organs

Organs are made up of one or more different kinds of tissue and carry out one (or sometimes more) main function or job. Our brain, ears, eyes and skin are examples of organs. Several organs working together make up a **system**.

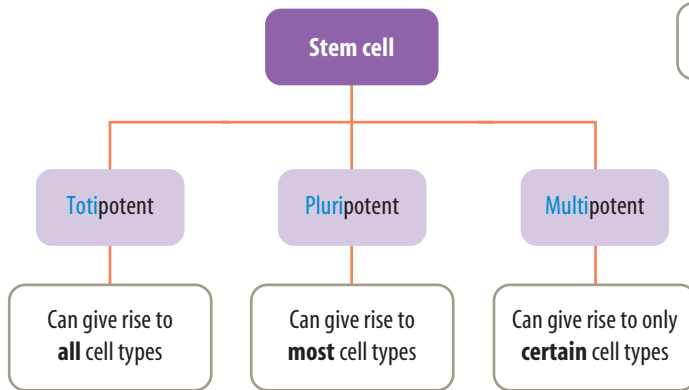


Stem cells

Have you heard or read about the issues regarding stem cells? What's the stem of the trouble? What are stem cells and why are people arguing about them?

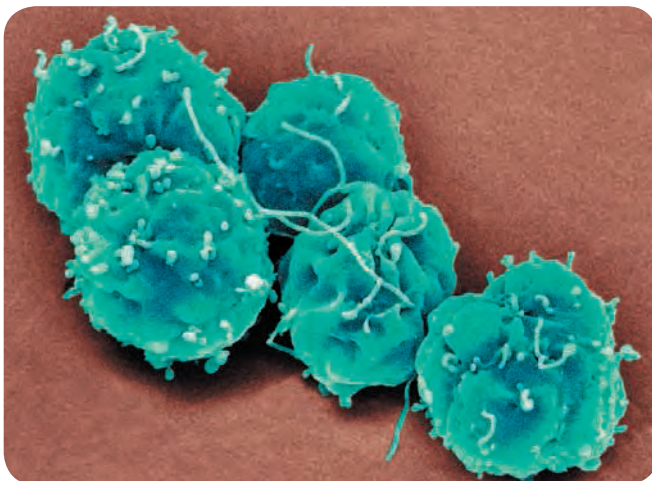
WHAT ARE STEM CELLS?

Stem cells are unspecialised cells that can reproduce themselves indefinitely. They have the ability to differentiate into many different and specialised cell types. Stem cells in a fertilised egg or zygote are **totipotent** — they have the ability to differentiate into *any* type of cell. The source of the stem cell determines the number of different types of cells that it can differentiate into.



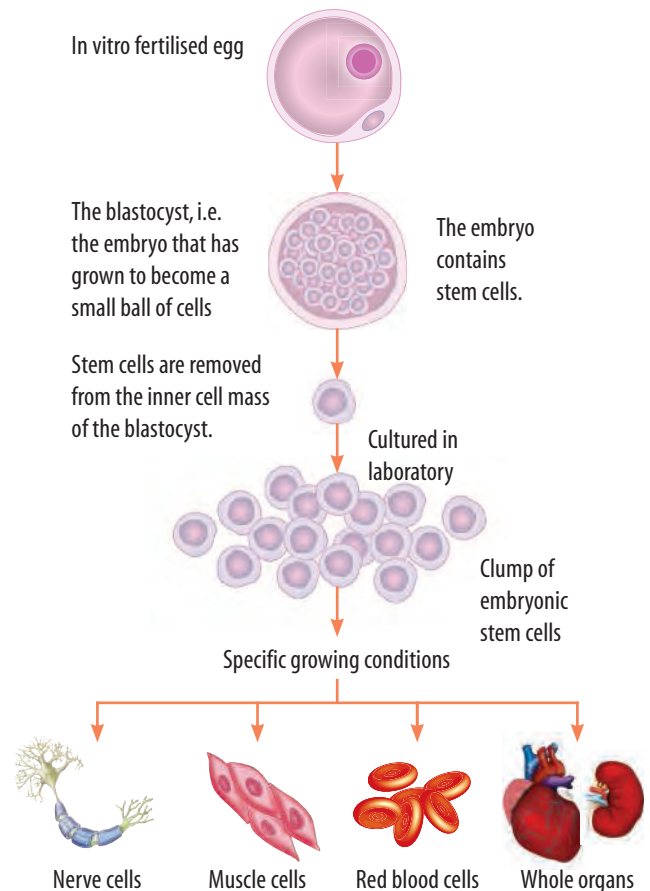
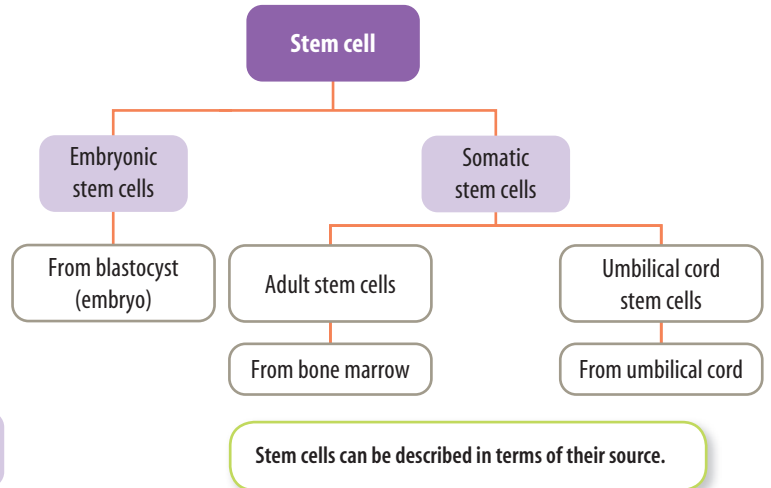
Stem cells can be divided into categories on the basis of their ability to produce different cell types.

The ability to differentiate into specific cell types makes stem cells invaluable in the treatment and possible cure of a variety of diseases. For example, they may be used to replace faulty, diseased or dead cells. The versatility of stem cells is what makes them very important.



WHAT ARE THE SOURCES OF STEM CELLS?

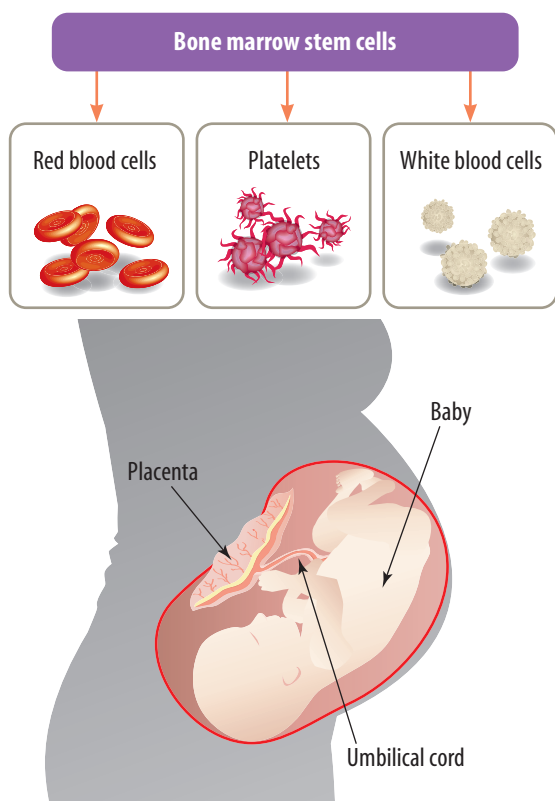
Embryonic stem cells can be obtained from the inner cell mass of a blastocyst. The blastocyst is the term used to describe the mass of cells formed at an early stage (5–7 days) of an embryo's development. Embryonic stem cells are **pluripotent** and can give rise to most cell types; for example, blood cells, skin cells, nerve cells and liver cells.



Embryonic stem cells are removed from the blastocyst and cultured to produce different cell types.

Somatic stem cells can be obtained from bone marrow and umbilical cord blood. Stem cells obtained from the bone marrow are often referred to as **adult stem cells**. These cells are **multipotent** and can develop into many kinds of blood cells.

The umbilical cord is the cord that connects the unborn baby to the placenta. This is how the baby gets nutrients and oxygen while it is still inside the mother's body. This cord contains stem cells that can develop into only a few types of cells, such as blood cells and cells useful in fighting disease. **Umbilical cord stem cells** can be taken from this cord when the baby is born.



STEM CELLS — MADE TO ORDER?

While the information in your genetic instructions tells your cells which types of cells they should become, scientists have also been able to modify the 'future' of some types of cells. By controlling the conditions in which embryonic stem cells are grown, scientists can either keep them unspecialised or encourage them to differentiate into a specific type of cell. This provides opportunities to grow replacement nerve cells for people who have damaged or diseased nerves. Imagine being

able to cure paralysis or spinal cord injury. In the future, stem cells may also be used to treat and cure Alzheimer's disease, motor neurone disease, Parkinson's disease, diabetes and arthritis.

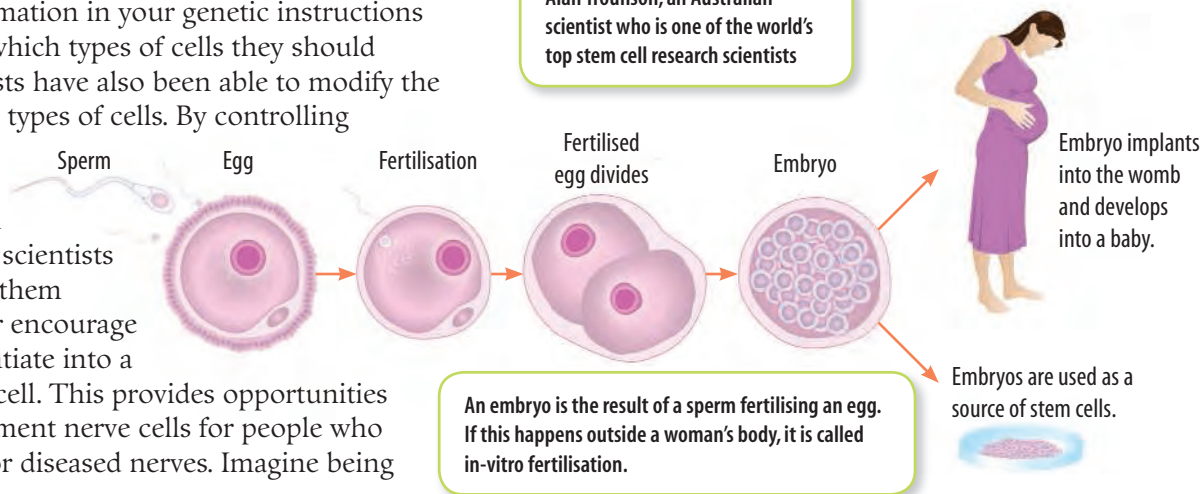
HOW ABOUT THAT!

Professor Alan Trounson is an Australian scientist who has spent a great part of his working life perfecting the technique for creating embryos outside the human body. He was part of the team that produced the first test-tube baby in Australia in 1980. He has also done a lot of work on embryonic stem cells. In 2000, his team showed that it was possible to produce nerve cells from embryonic stem cells.

He was recently appointed as the president of a Californian institute that specialises in stem cell research. It is the best-funded facility of its kind in the world, so Trounson will have the best facilities at his disposal to move stem cell research forwards.



Alan Trounson, an Australian scientist who is one of the world's top stem cell research scientists



SO WHAT'S THE PROBLEM?

It is the source of embryonic stem cells that raises so many issues. Embryonic stem cells can be taken from spare human embryos that are left over from fertility treatments or from embryos that have been cloned in the laboratory. Some argue that this artificial creation of an embryo solely for the purpose of obtaining stem cells is unethical. There has also been concern about the fate of the embryo. In the process of obtaining stem cells, the embryo is destroyed.

Some parents have decided to have another child for the sole purpose of being able to provide stem cells for a child who is ill or has a disease. In this case, the blood from the umbilical cord or placenta is used as the source. Some suggest that this is not the 'right' reason to have a child and that they should not be considered to be a 'factory' for spare parts for their siblings.

Open minds are crucial in the debate on stem cell research

Politicians who decide on issues involving complex science need to be thoroughly briefed . . .

Sydney Morning Herald, 24 March 2006

We must move ahead on stem cells
To maintain its world-leading reputation, Australia needs to change the law to allow the therapeutic cloning of cells.

The Age, 30 September 2005

Discovery offers hope on cancer

Melbourne researchers have taken a giant step towards understanding the genesis of breast cancer by inducing female mice to grow new mammary glands from stem cells.

The Age, 5 January 2006

RADICAL BID TO GROW NEW BONE

STEM CELL THERAPY A WORLD FIRST

Michelle Pountney

Health reporter, 6 April 2006

A MELBOURNE man is the first person in the world whose own stem cells are being used to try to mend a broken leg.

The cutting-edge stem-cell technology has helped Jamie Stevens, 21, back on his feet.

A motorcycle crash nine months ago left him with a severely broken left thigh bone. Part of the femur stuck through his leg, and other parts of the bone were missing.

The bone failed to heal and Mr Stevens's leg was held together by a large titanium plate.

Royal Melbourne Hospital orthopedics director Richard de Steiger decided Mr Stevens was the ideal first patient for a revolutionary stem-cell trial at the hospital.

About seven weeks ago, Mr de Steiger harvested bone marrow from Mr Stevens' pelvis. The adult stem cells were then separated from the other cells. A sub-group of stem cells called mesenchymal precursor cells — those that can transform into tissues including bone cartilage and heart — were isolated and grown.

Last week about 30 million of these cells were implanted into the 5 cm × 3 cm hole in Mr Stevens' thigh bone. The cells are expected to regenerate new bone and grow through the calcium phosphate.

Yesterday, just four days after surgery, Mr Stevens went home. 'It's good to be part of something that is on the brink,' he said. 'I wouldn't say I understand it. It's all pretty cool.'

It will be three to four months before the result of the operation is known.

'This is radical and the first procedure in the world to use a patient's own stem cells and make them turn into bone-forming cells that are the patient's own cells, to stimulate healing of a fracture,' Mr de Steiger said.

The cells are harvested, cultured and expanded using Australian biotechnology company Mesoblast's specialist adult stem-cell technology.

Mr de Steiger hopes that eventually the technique will be refined to a simple injection, avoiding further surgery.

Using a patient's own cells avoids the potential problem of the body's rejection of foreign cells.

The only other alternative to repair Mr Stevens' leg would have been a painful bone graft, taking a chunk of bone from his hip and plugging it into the hole in his thigh.

'The conventional way used over many years involves a large incision at the pelvis and taking out quite a large amount of bone in Jamie's case,' Mr de Steiger said.

'In this situation there is the risk of a separate incision, reported continuing pain from that incision, and separate infection risk at that site.'

Mr de Steiger said orthopedic specialists at the Royal Melbourne hospital treated about 200 fractures of the long leg bones each year.

About 19 per cent become 'non-union' fractures that fail to heal; 10 of these patients will be recruited to be part of the year-long trial.

Mr Stevens said he was no more nervous about being the first patient in the world to have the procedure than he would have been having a graft.

'I think the benefit outweighs the old procedure, and being able to avoid having a big chunk of bone taken out of the hip . . . the recovery period of it was a lot quicker.'

After living in limbo for nine months, Mr Stevens said he was looking forward to resuming the life he enjoyed before his accident.

If there are too many arguments about using someone else's stem cells, why not grow your own to mend, replace and renew?

UNDERSTANDING AND INQUIRING

REMEMBER

- 1 What do organisms have in common with other matter in the universe?
- 2 Describe the relationship between atoms, molecules and organelles.
- 3 In what ways can cells be different from each other? Why do cells differ?
- 4 What are the differences between cells, tissues, organs and systems?
- 5 What are stem cells?
- 6 Distinguish between the terms 'totipotent', 'pluripotent' and 'multipotent'.
- 7 Outline the importance of stem cells.
- 8 List sources of stem cells.
- 9 Outline issues regarding stem cell research.
- 10 Describe a scientific contribution made by the Australian scientist Professor Alan Trounson.

THINK AND REASON

Use the mind maps on page 79 to answer the following questions.

- 11 What kind of tissue:
 - (a) has the function of conducting and coordinating messages around the body?
 - (b) binds and connects tissues?
 - (c) supports the body?
 - (d) carries oxygen around the body?
- 12 Which body system has the function of:
 - (a) detecting stimuli?
 - (b) supporting and moving the body?
 - (c) taking in oxygen and getting rid of carbon dioxide?
 - (d) conducting messages from one part of the body to another?

INVESTIGATE, CREATE AND DESIGN

- 13 Find out about the different tissues and systems that exist in plants. Present your information, using diagrams and lots of colour, on a poster or as a PowerPoint presentation. Be as creative as you can.
- 14 Select one of the systems in the mind map on page 79 and find out more about what it does and how it works.
- 15 Design and construct a model of one of the following systems: respiratory, excretory, reproductive, digestive.

INVESTIGATE, SHARE AND DISCUSS

- 16 Investigate some of the following questions.
 - (a) Which inherited genetic diseases are potentially treatable with stem cells?
 - (b) How many different kinds of adult stem cells exist and in which tissues can they be found?
 - (c) Why have the adult stem cells remained undifferentiated?

- (d) What are the factors that stimulate adult stem cells to move to sites of injury or damage?

eBookplus

- 17 View an animation about stem cells by going to the website for this book and clicking on the **Genetic Science Learning Center** weblink in your eBookPLUS. Use these ideas to construct your own story, cartoon, PowerPoint presentation or animation on stem cells.
- 18 Click on the **Stem Cell** weblink in your eBookPLUS to investigate the views of the major world religions on stem cell research.
- 19 In your team, discuss the following questions to suggest a variety of perspectives.
 - (a) Is it morally acceptable to produce and/or use living human embryos to obtain stem cells?
 - (b) Each stem cell line comes from a single embryo. A single cell line allows hundreds of researchers to work on stem cells. Suggest and discuss the advantages and disadvantages of this.
 - (c) If the use of human multipotent stem cells provides the ability to heal humans without having to kill another, how can this technology be bad?
 - (d) Parents of a child with a genetic disease plan a sibling whose cells can be used to help the diseased child. Is it wrong for them to have another child for this reason?
- 20 Find out how stem cell research is regulated in Australia and in one other country. What are the similarities and differences of the regulations? Discuss the implications of this with your team-mates.
- 21 Investigate aspects of stem cell research and put together an argument for or against the research and its applications. Find a class member with the opposing view and present your key points to each other. Ask questions to probe any statements that you do not understand or would like to clarify. Construct a PMI to summarise your discussion.
- 22 Investigate and report on research at the Australian Stem Cell Centre.
- 23
 - (a) Use a bubble map or mind map to summarise the key points in the article *Stem cell therapy a world first* on page 82.
 - (b) As a team, discuss the article and construct a PMI.
 - (c) Formulate questions that may help you to develop an informed opinion.
 - (d) Research your questions.
 - (e) State your opinion on the use of stem cell therapies like the one in the article. Give reasons for your opinion.
 - (f) Do you have the same opinion about other types of stem cell therapies? Explain.

Focus on plant cells

If all living things are made up of cells, why aren't they all the same?

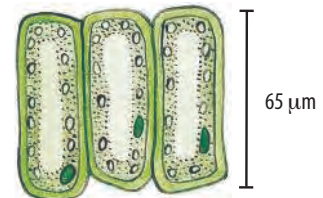
Have or have not

Like animal cells, plant cells have cytoplasm, a membrane and a nucleus. Unlike animal cells, plant cells have a cellulose cell wall and a large central vacuole filled with cell sap. Often plant cells also contain chloroplasts, which enable them to make their own food.

On the surfaces of leaves, there are pairs of special cells called guard cells, which surround tiny pores called stomata. The guard cells can change shape, opening or closing the stomata. Special cells on the roots extend into microscopic hairs that penetrate between soil particles. The hairs provide a big surface area through which water may be absorbed from the soil.

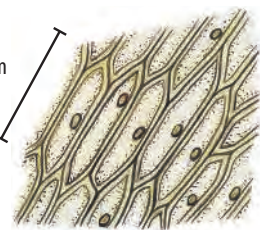
Leaf cells (palisade cells)

The main function of leaf palisade cells is to photosynthesise, so they are packed with chloroplasts and are usually green.



Leaf cell

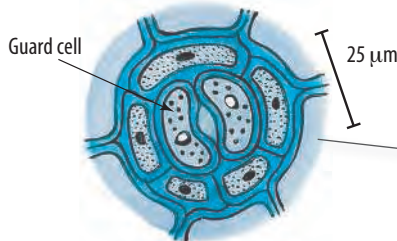
150 µm



Epidermal cells

Epidermal cells

Epidermal cells are found on the outside of the plant. They form an outer skin for the plant and protect the cells underneath. This explains why they need a flat shape and why they interlock like tiles. Epidermal cells do not usually photosynthesise so they lack chloroplasts. Light needs to pass through them, and they are usually transparent. The cells in the diagram above are onion epidermal cells.



Guard cell

Guard cells
Guard cells are kidney-shaped cells found on the surface of leaves. They can change shape to either open or close the small hole between them. The small holes, called stomata (or stomates), allow substances such as carbon dioxide to enter the leaf. They also let water out of the leaf. Most plants open their stomata at night; they close their stomata during the day (when it is hotter) to conserve water.



Xylem cells

Xylem cells

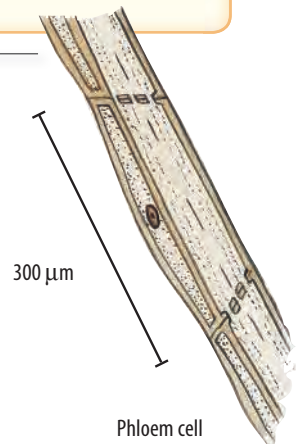
Xylem cells form xylem tubes, which carry water and dissolved minerals from the roots to all parts of the plant. They are made up of dead xylem cells joined end to end. When xylem cells die, the cell walls at each end of the cells dissolve, forming a long straw-like tube. They have thick cell walls with lots of cellulose to make the xylem tubes strong.

WHAT DOES IT MEAN?

The word *xylem* comes from the Greek word *xulan*, meaning 'wood'. The word *phloem* comes from the Greek word *phloos*, meaning 'bark'.

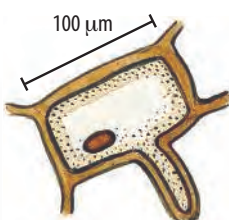
Phloem cells

Like xylem cells, phloem cells form tubes. The tubes formed by phloem cells carry the food made in the leaves to all parts of the plant. Phloem cells do not need to die to do this job. The ends of phloem cells have holes and look like sieves.



Phloem cell

Some of the types of cells found in plants



Root hair cell

Root hair cells

Root hair cells absorb water and dissolved minerals from the soil. They have small hairs, called root hairs, on their surface. This increases the surface area of the root cells so that they can soak up water more quickly.

INQUIRY: INVESTIGATION 3.7

Plant cells in view

KEY INQUIRY SKILL:

- processing and analysing data and information

Equipment:

light microscope

prepared plant slides: leaf epidermal cells, root hair cells, stomata/guard cells

- Construct a table like the one below, making it large enough for all of your results.

- Use a microscope to observe the prepared slides, recording your observations in the table as you make them.
- Prepare a summary table that describes the similarities and differences observed between the different cells examined.

DISCUSS AND EXPLAIN

- Which features did the plant cells have in common?

- In what ways did the plant cells differ from each other?
- Why are there some features that all cells possess?
- Find out the functions of the different types of cells examined.
- Suggest how the shape or size of a cell may assist it in doing its job.
- Suggest reasons for some of the differences observed between the cells.

Source of specimen	Type of specimen	Sketch of specimen	Description of specimen
Plant	Leaf epidermal cells	[Allow as much space as you can; draw only 2–3 cells, in pencil, and include magnification and estimated size.]	[Describe in words what the specimen looked like.]

UNDERSTANDING AND INQUIRING

REMEMBER

- Match the types of cells with their functions.

Type of cell	Function
Root hair	Changes shape to open and close pores in the leaf
Xylem	Increases surface area for efficient absorption
Guard	Carries water and minerals up the plant

- Which features do most cells have in common?
- Describe some ways in which cells may differ.
- Suggest why the cells in a multicellular organism are not all the same. Give examples in your answer.

THINK AND REASON

- (a) Use the illustrations on page 84 to find the sizes of these different types of plant cells.
 - Leaf cell
 - Onion epidermal cell
 - Phloem cell
- Summarise your data in a table.
- Determine the average size of a plant cell.
- Use a bar graph to plot the cell sizes of the different types of cells.
- Comment on the differences between the cells.

THINK

- Copy and complete the table below.

Cell structures and functions in plant cells

Structure	Function
Cell wall	
Cytoplasm	
Chloroplast	
Nucleus	
Large vacuole	
Cell membrane	

INVESTIGATE, IMAGINE AND CREATE

- Find out more about guard cells or leaf epidermal cells. Write a story about what happens to them over 24 hours.
- Construct a model of a pair of guard cells, using balloons.
- Using your own research and the information on page 84, construct a 'peep through' learning wheel that shows the structure and function of the different types of plant cells. Instructions for making a 'peep through' learning wheel are given on page 77.

work
sheet

→ 3.4 Plant transport highways

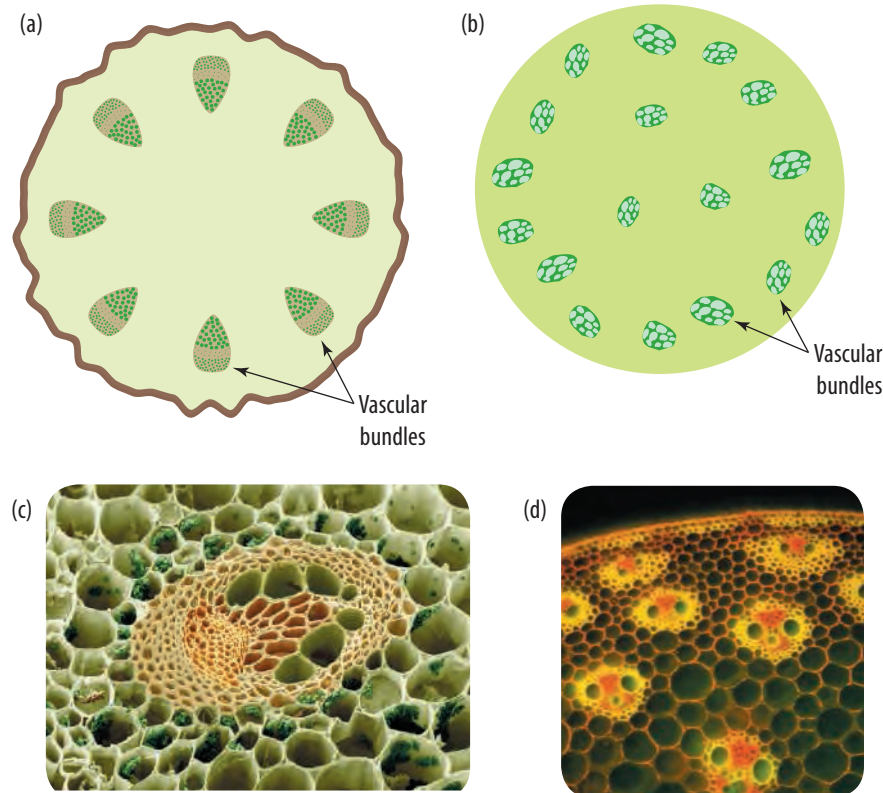
Plant cells — holding, carrying and guarding

As in animals, plant cells can work together for a variety of functions to meet their survival needs. Plants have their own transport systems, which consist of many thin tubes made up of different

types of cells. Other types of plant cells are involved in water regulation and exchange of important gases, like oxygen and carbon dioxide with their environment.

Sweet transport: phloem

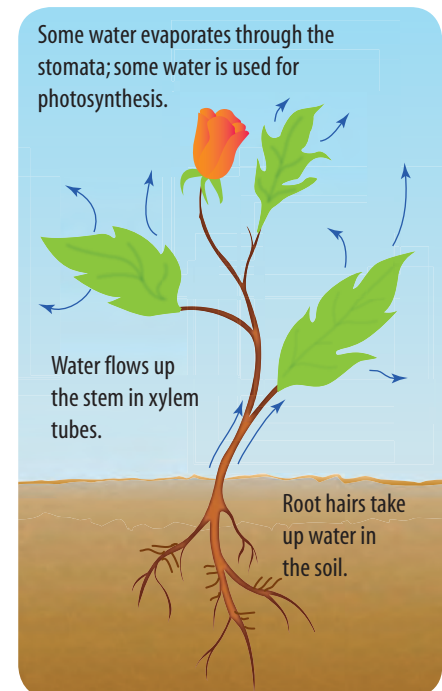
Using the process of photosynthesis, plants make sugar in their leaves. The system of thin-walled tubes that carries this sugar (in the form of glucose or sucrose) from the leaves to other parts of the plant is called **phloem**. Phloem consists of living cells called sieve tubes and companion cells. The transport of the sugar solution up and down the plant is called **translocation**.



Diagrams of typical cross-sections of the stem of (a) a young dicot and (b) a monocot. The photographs show how the cells of (c) a dicot (buttercup) appear when viewed under an electron microscope and (d) a monocot (corn) appear under a light microscope.

Water pipes: xylem

Flowering plants also have tubes with strong, thick walls that carry water and minerals up from the roots through the stem to the leaves. These are called **xylem vessels**. These tubes are formed from the empty remains of dead cells, the walls of which are strengthened with a woody substance called **lignin**. The



The movement of water from roots to leaves is known as the transpiration stream.

INQUIRY: INVESTIGATION 3.8

Stem transport systems

KEY INQUIRY SKILLS:

- processing and analysing data and information
- planning and conducting

Equipment:

celery stick (stem and leaves) blue food colouring
knife red food colouring
two 250 mL beakers hand lens
water

- Slice the celery along the middle to about halfway up the stem.
- Fill two beakers with 250 mL of water. Colour one blue and the other red with the food colouring.
- Place the celery so that each 'side' of the celery is in a separate beaker.
- Leave for 24 hours and then observe the celery.
- Cut the celery stick across the stem.
- Use the hand lens to look at the inside of the stem.

DISCUSS AND EXPLAIN

- 1 Look at where the water has travelled in the celery. Draw a diagram to show your observations.

- 2 Draw a diagram to show what you can see when you cut across the stem.
- 3 Where is the differently coloured water found in the stem?
- 4 Where are the different colours found in the leaves?
- 5 Draw a diagram of the whole celery stick and trace the path of the water through each side to the leaves.
- 6 How could you turn a white carnation blue? Try it.



xylem is therefore a 'dead' one-way street, rather than a 'living' two-way highway like the other transport tubes you have studied.

Water moves up from the roots of the plant, through its stem and to its leaves, where some may pass out of the plant as water vapour through pores called **stomata**. This movement of water is called the **transpiration stream**.

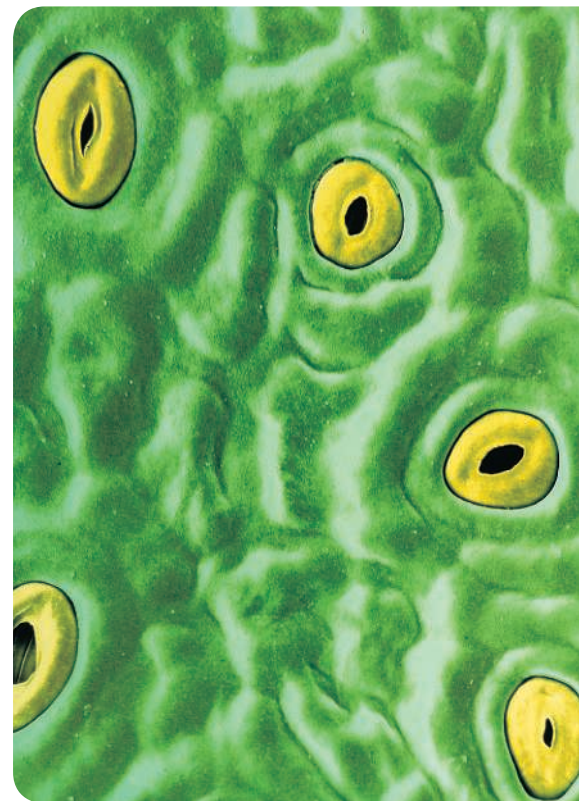
XYLEM FOR SUPPORT

The phloem and the xylem vessels are located together in groups called **vascular bundles**. The strong, thick walls of the xylem vessels are also important in helping to hold up and support the plant. The trunks of trees are made mostly of xylem. Did you know that the stringiness of celery is due to its xylem tissues?

Leaf doorways: stomata

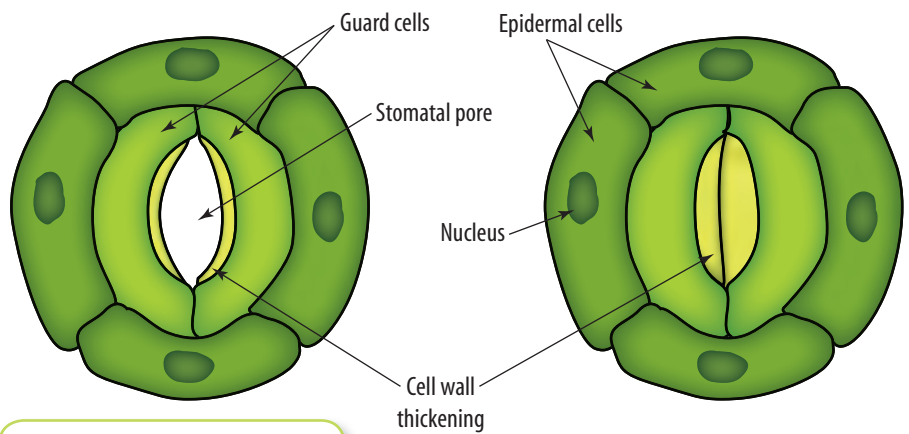
Water transport occurs within the xylem vessels. Some of the water that is transported through the xylem to the leaves is used in photosynthesis. Some water is also lost as water vapour through tiny holes or pores in the leaves. These tiny pores, called stomata (or stomates), are most frequently found on the underside of the leaves. Evaporation of water from the stomata in the leaves helps pull the water up the plant. Loss of water vapour through the stomata is called **transpiration**.

'Stomata art': the arrangement of stomata in a plant



GUARD CELLS IN CONTROL

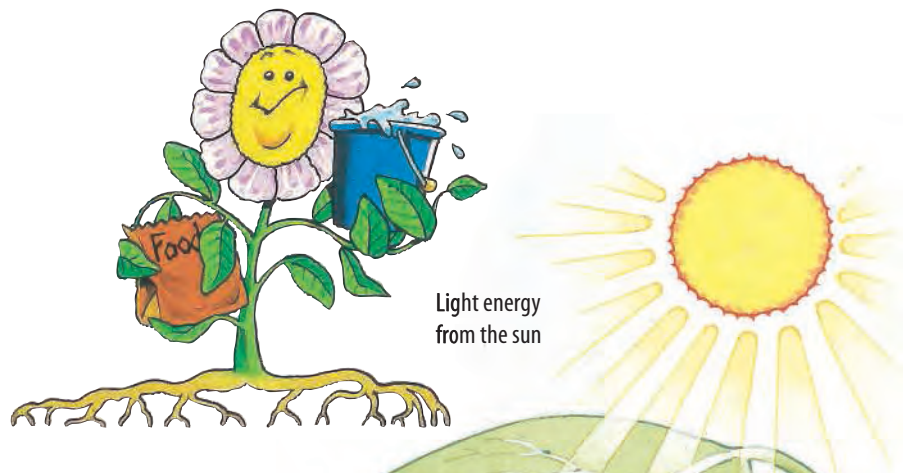
Oxygen and carbon dioxide gases also move in and out of the plant through the stomata. **Guard cells**, which surround each stoma, enable the hole to open and close, depending on the plant's needs. When the plant has plenty of water, the guard cells fill up with water and stretch lengthways. This opens the pore. If water is in short supply, however, the guard cells lose water and they collapse towards each other. The pore is then closed. This is one way in which the plant can control its water loss.



Stomata can close to conserve water.

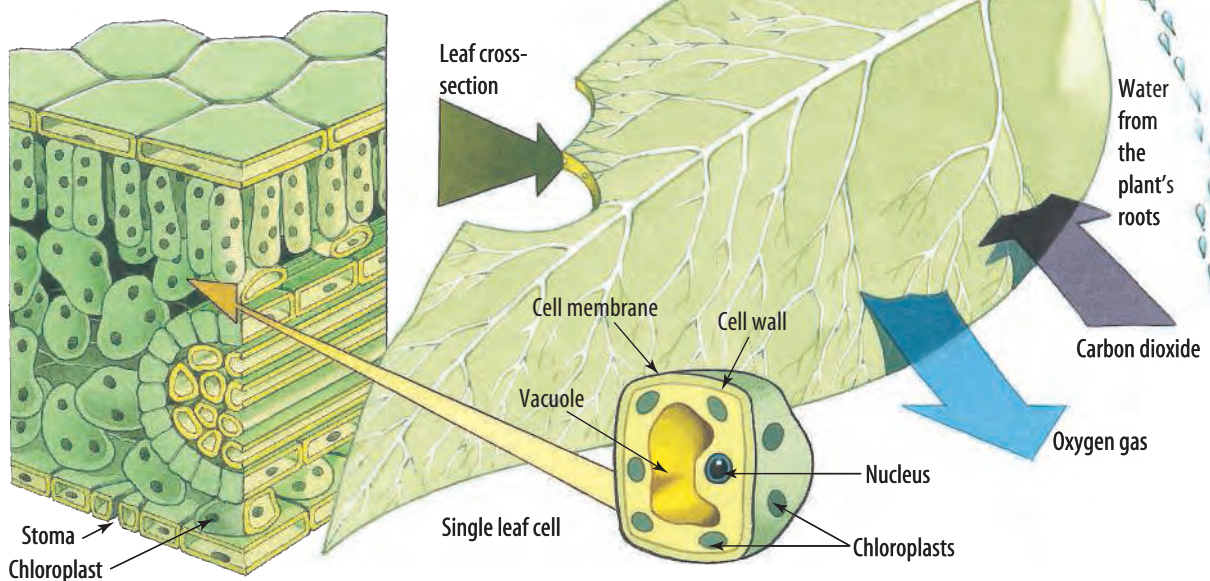
DUSTY DOORS

Air pollution can result in particles of dust settling on the leaves of plants. This may limit the amount of light reaching the leaf and so reduce photosynthesis. If these dust particles block up stomata, they can also affect transpiration and gaseous exchange.



HOW ABOUT THAT!

Although water makes up about 90–95 per cent of the living tissues of plants, water is often being lost to their surroundings. As much as 98 per cent of the water absorbed by a plant can be lost through transpiration. A variety of factors affect the amount of water that plants lose. Weather is a major factor, as high temperatures, wind and low humidity can increase the evaporation of water from the stomata. It has been recorded that large trees may lose more than 400 litres of water in a day.



INQUIRY: INVESTIGATION 3.9

Observing leaf epidermal cells

KEY INQUIRY SKILLS:

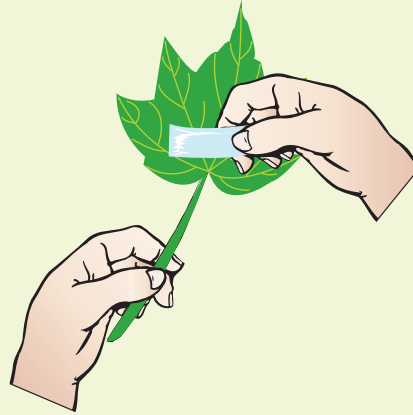
- processing and analysing data and information
- planning and conducting

Equipment:

leaf clear sticky tape
microscope slide microscope

You can make a 'slide' of leaf epidermal cells with sticky tape.

- Put some sticky tape over a section of the underside of a leaf.
- Press the sticky tape firmly onto the leaf.
- Tear the tape off. Some of the lining cells should come off with the sticky tape.
- Press the tape, sticky side down, onto a microscope slide.
- View the sticky tape under the microscope.
- Try to find a pair of guard cells and one of the stomata.



DISCUSS AND EXPLAIN

- 1 Is the stoma (the opening) open or closed?
- 2 Make a drawing of a group of cells, including the guard cells. Include as much detail in your drawing as possible.
- 3 Label the guard cells and stomata.
- 4 Title and date your drawing. Write down the magnification used.

HOW ABOUT THAT!

Scientists have used genetic engineering technology to produce plants that glow particular colours when they

have mineral deficiencies. This provides farmers with information about which soils need extra minerals added.

INQUIRY: INVESTIGATION 3.10

Looking at chloroplasts under a microscope

KEY INQUIRY SKILLS:

- processing and analysing data and information
- planning and conducting

Equipment:

tweezers
moss, spirogyra or elodea
water
light microscope, slides, coverslips
dilute iodine solution

- Using tweezers, carefully remove a leaf from a moss or elodea plant or take a small piece of spirogyra.

- Place the plant material in a drop of water on a microscope slide and cover it with a coverslip.
- Use a light microscope to observe the leaf.
- Put a drop of dilute iodine solution under the coverslip. (Iodine stains starch a blue-black colour.)
- Using the microscope, examine the leaf again.

DISCUSS AND EXPLAIN

- 1 Draw what you see before staining.
- 2 Label any chloroplasts that are present.
- 3 Describe the colour of the chloroplasts before staining.
- 4 What gives chloroplasts their colour?
- 5 Did the iodine stain any part of the leaf a dark colour?
- 6 If so, what does this suggest?
- 7 What conclusions can you make about chloroplasts?

Moving in or out?

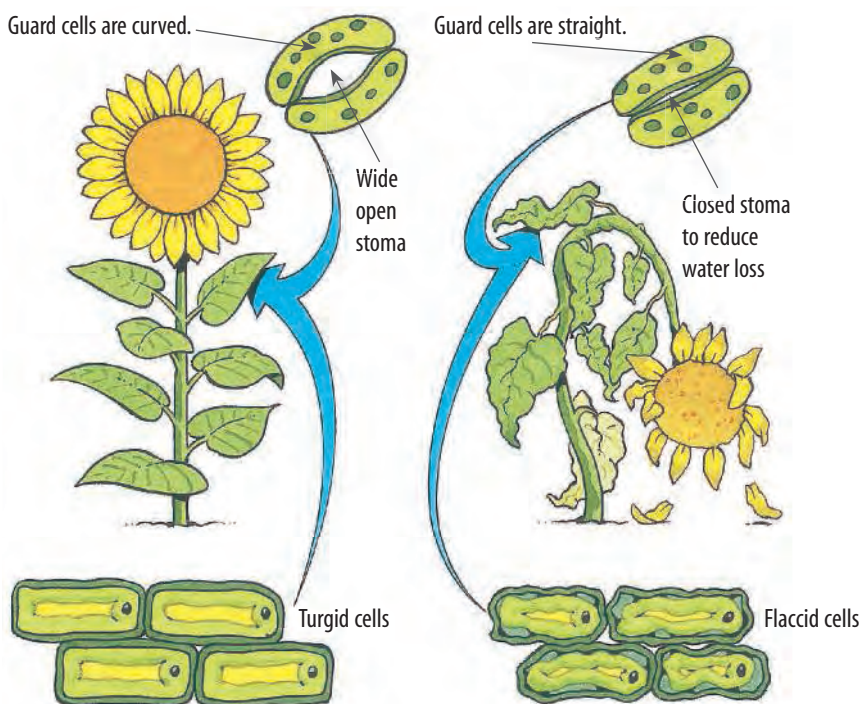
The movement of substances into and out of cells is controlled by the cell membrane. This enables useful substances to be delivered into the cells and waste products to be moved out. Some types of movements require energy and others do not.

Oxygen and carbon dioxide enter the cell by a process called diffusion. Diffusion moves substances from where they are in a high concentration to where they are in a low concentration and so does not require energy. Water moves across the membrane by a special type of diffusion called osmosis. This movement of water into and out of the guard cells is responsible for opening and closing the stomata.

If the cells of a plant do not contain enough water, they become flaccid and the plant wilts.

Flaccid or firm?

If too much water is lost or not enough water is available, the plant may **wilt**. When this occurs, water has moved out of the cell **vacuoles** and the cells have become soft or **flaccid**. The firmness in the petals and leaves is due to their cells being firm or **turgid**.



INQUIRY: INVESTIGATION 3.11

Moving in or out?

Equipment:

two 20 cm lengths of dialysis tubing
starch solution iodine solution
scales 2 beakers

- Soak the dialysis tubing in water so it becomes soft.
- Tie a knot at one end of each piece of dialysis tubing. This will form two small bags.
- Pour water into bag A until it is one-third full. Pour the same amount of starch solution into bag B and add 10 drops of iodine solution.
- Tie a knot at the top of each bag to seal them.
- Weigh both bags.
- Put bag A in a beaker of starch solution. Add enough iodine to the starch solution to produce a dark blue colour.
- Put bag B in a beaker of water.
- Leave the two bags undisturbed for at least two hours (or overnight).
- Weigh the bags again.

DISCUSS AND EXPLAIN

- 1 Draw up a table to record the weights of the bags before and after being left in the beakers.
- 2 What happens to iodine when it is added to starch solution?
- 3 Draw bags A and B in the beakers they were left in. On your diagram, label where blue and yellow colour can be seen.
- 4 In this experiment, we made a model of a cell. Which part represented the cell membrane?
- 5 Dialysis tubing allows some substances, but not others, to pass through. Which of the following substances could pass through the dialysis tubing and which could not? What evidence supports this? (a) Starch (b) Water (c) Iodine
- 6 Did the masses of the two bags change? What caused it to change?
- 7 When water moves in or out of cells by osmosis, it moves in the direction that balances the concentrations of substances inside and outside the cell. Use this information to explain why the masses of the bags changed.

UNDERSTANDING AND INQUIRING

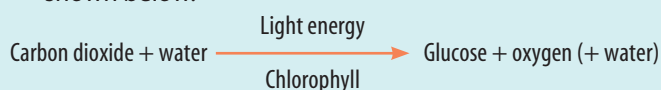
REMEMBER

- 1 What is the name for the tubes that carry sugar solution around the plant?
- 2 Describe the difference between:
 - (a) phloem and xylem vessels
 - (b) sugar and water transport in plants
 - (c) the arrangement of vascular bundles in dicots and monocots.
- 3 In what ways are the vascular bundles important to plants?
- 4 State two things that may happen to water in a plant.
- 5 On which part of the plant are stomata usually found? Can you suggest why?
- 6 What helps 'pull' water up the plant?
- 7 Describe how the guard cells assist the plant in controlling water loss.
- 8 Describe the difference between flaccid cells and turgid cells.
- 9 Copy and complete the table below.

Tissue	What it carries	Direction of movement	Name of cells that form tubes	Are cells that form tubes living?
Xylem				
Phloem				

THINK AND DISCUSS

- 10 Carefully examine the reaction for photosynthesis as shown below.



- (a) Suggest why water and carbon dioxide are so important to plants.
- (b) Suggest why guard cells are important to plants.
- (c) Predict consequences for a plant if the guard cells close the stomata for long periods of time.

INVESTIGATE

- 11 Describe the patterns in which the vascular tissue is arranged in the stems of different plants. Obtain your information by:
 - (a) examining stained cross-sections
 - (b) finding and examining diagrams of the stems of different plants in cross-section.
- 12 Find out the relationship between 'wood' and xylem tissue.
- 13 How long do you think it would take for a plant to take up 50 mL of water? What conditions might speed it up? Put forward a hypothesis, and then design an experiment to test your hypothesis.

- 14 Design an experiment to test the time taken for different volumes of water to be taken up by the plant.
- 15 Some plants have special features that help them reduce water loss. Some leaves have a thick, waxy layer (cuticle). Others have a hairy surface or sunken stomata. Plants that are able to tolerate extremely dry environments are called xerophytes. Find out some ways in which plants in dry environments, such as deserts, reduce their water loss. Present your information on a poster or as a model.
- 16 Using sticky tape, remove a layer of cells from the underside of a leaf and then place it on a glass microscope slide. Examine the leaf cells for stomata under a light microscope. Repeat the procedure with as many different types of plants as you can. Summarise your findings in a poster.
- 17 Design an experiment to measure the amount of water lost through the leaves of a plant.
- 18 Place a plastic bag over the leaves of plants growing in the school grounds. Seal the bag and record the amount of water collected over 24 hours. What conclusions can you draw from your results?
- 19 Suggest ways in which plants can trap as much light as possible, presenting them in a mind map.
- 20 Research and report on one of the following types of science.
 - Phycology (study of seaweeds)
 - Plant marine biology
 - Plant physiology
 - Plant pathology
 - Ecophysiology

CREATE

- 21 In a group, write and then act out a play or simulation of the way water moves through a plant.
- 22 Write a story about a group of water molecules that travels from the soil, through a plant and then into the atmosphere as water vapour.
- 23 Design experiments to determine the answer to one of the following questions.
 - (a) Is carbon dioxide needed for photosynthesis?
 - (b) Do plants need chlorophyll for photosynthesis?
 - (c) If part of a leaf is covered, will the leaf still photosynthesise?
 - (d) If a plant is covered with a plastic bag, will it still photosynthesise?
 - (e) How could you determine the best light (colour or intensity) for photosynthesis?

work
sheets

3.5 Leafy exchanges
3.6 Photosynthesis

Cell division

All cells arise from pre-existing cells.

Cell division in eukaryotes

Ouch! Did you burn or cut yourself? What about those skin cells you left on the towel when you dried yourself and those hairs you left behind in your brush? Have you replaced these cells? Throughout the life of multicellular organisms, cell division takes place to enable growth, development, repair and replacement of cells. Cell division also plays an important role in reproduction.

NUCLEUS, CHROMOSOMES AND DNA

All eukaryotic cells have a **nucleus**, which contains genetic information with instructions that are necessary to keep the cell (and organism) alive. This information is contained in structures called **chromosomes**, which are made up of a chemical called **deoxyribonucleic acid (DNA)**.

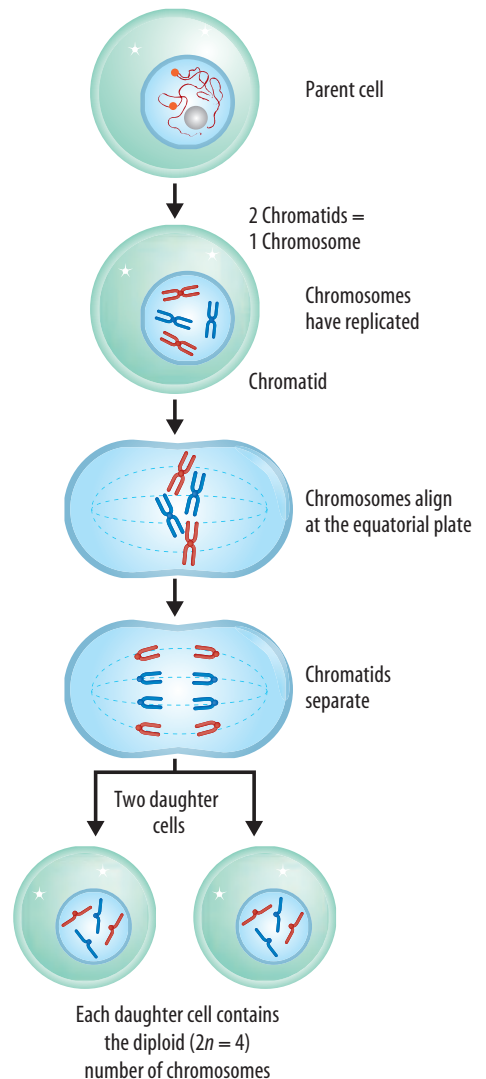
MITOSIS

Mitosis is the name of a process involved in cell division in eukaryotic cells. Some organisms use this type of cell division to asexually reproduce. Multicellular organisms also use mitosis to produce cells for growth, development, repair and replacement.

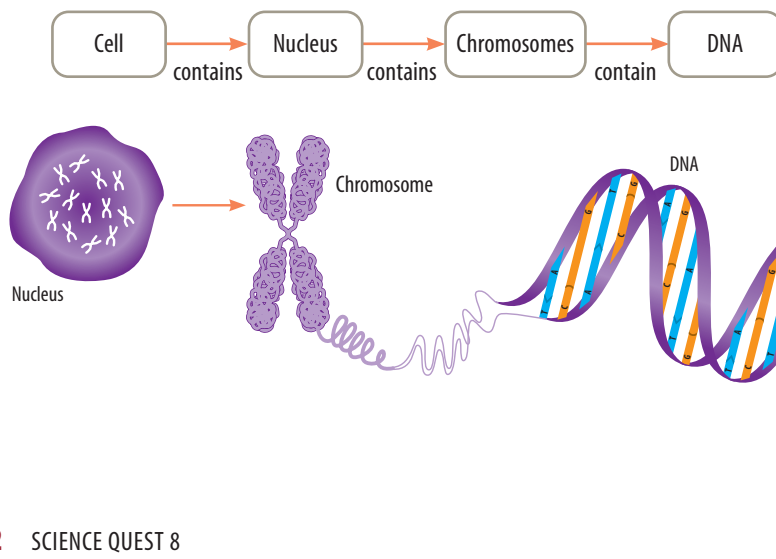
The cells produced by mitosis are genetically identical to each other and to the original cell. They have the same number and types of chromosomes and DNA instructions. As they have identical genetic information, they are described as being **clones**.

CYTOKINESIS

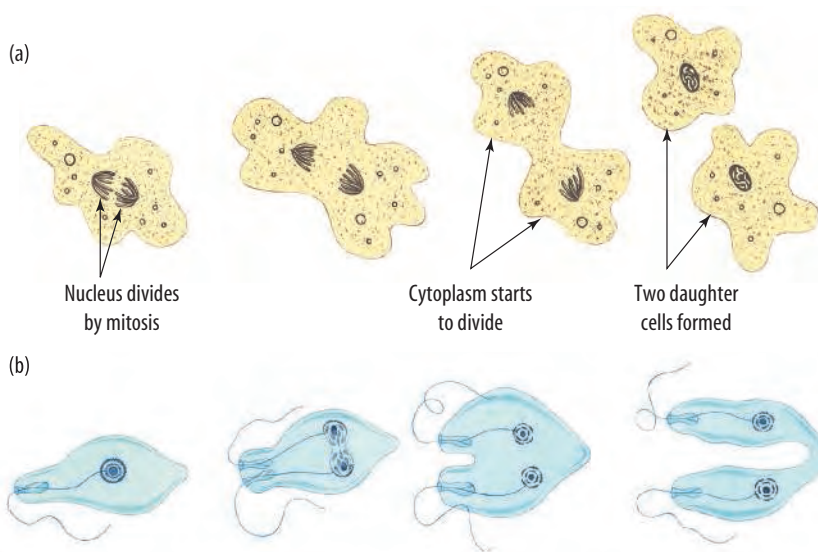
Mitosis is a process that involves division of the nucleus. Once a cell has undergone this process, the cell membrane pinches inwards so that a new membrane is formed, dividing the cell in two. This process of the division of the cytoplasm is called **cytokinesis**.



Mitosis is a type of cell division that produces identical cells.



DNA makes up chromosomes, which are located in the nucleus of the cell.



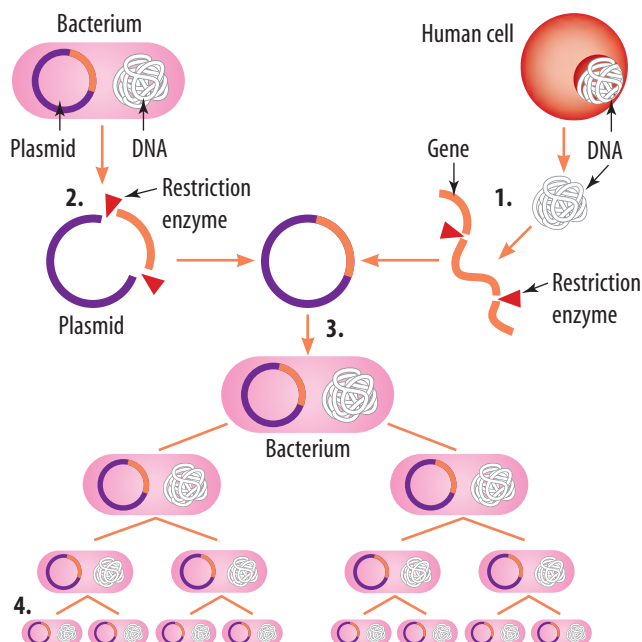
Eukaryotic unicellular organisms like (a) *Amoeba* and (b) *Euglena* divide by binary fission involving mitosis.

CELL DIVISION IN PROKARYOTES

Prokaryotes (such as bacteria) reproduce themselves by dividing into two using a process called binary fission. Although, binary fission also occurs in some eukaryotes, this type is much less complex, as prokaryotes do not have a nucleus. The cells produced are clones; they are identical to each other and to the cell from which they originate.

USING BACTERIA TO MAKE HUMAN PROTEINS

Knowledge of how bacteria reproduce can be used to get them to make human proteins. Scientists can insert genetic instructions from other organisms (including humans) into bacterial cells. When these bacterial cells divide, they produce cells that also contain the inserted foreign DNA and are able to make the protein that it codes for.



Bacteria can produce human insulin if the insulin gene is inserted into the bacterial cells.

This technology can be used in the production of insulin, a protein used in the treatment of a type of diabetes. The rapid rate of bacterial reproduction results in many cells with the human DNA and the production of useful quantities of this useful human protein.

CELL DIVISION AND DISEASE

Diseases can be divided according to whether they are infectious or non-infectious. **Infectious diseases** can be transferred from one organism to another. Tetanus and tuberculosis are examples of infectious diseases in which the cells are damaged by a bacterial infection. **Non-infectious diseases** are not transferred between organisms. Cancer is an example of a non-infectious disease that can be considered as a form of uncontrolled cell division or a disease of mitosis.

Scientists use their knowledge of cell division of disease-causing organisms to control or kill them. **Antibiotics** can be used to kill bacteria inside your body. **Disinfectants** can be used to kill bacteria on surfaces of non-living objects. Disinfectants should not be used on your skin as they can damage your cells. **Antiseptics** can be used on your skin. Antiseptics that kill bacteria are referred to as **bactericidal**, and those that stop bacteria from growing or dividing (but do not kill them) are called **bacteriostatic**.

INQUIRY: INVESTIGATION 3.12

Mitosis: patterns of order

KEY INQUIRY SKILLS:

- planning and conducting
- processing and analysing data and information
- evaluating
- communicating

Equipment:

light microscope

prepared onion root tip cells showing various stages of mitosis

- Use a light microscope to observe the prepared slides.
- Construct labelled diagrams to record your observations.

DISCUSS, EXPLAIN AND INVESTIGATE

- 1 Carefully observe your diagrams, noting any similarities or differences between your observations for each slide.

- 2 Discuss your observations with at least two other students.
- 3 Construct a table that summarises similarities and differences between the slides showing various stages of mitosis.
- 4 Comment on any patterns that you have observed.
- 5 Use the mitosis diagram on page 92 to suggest a sequence or order for the mitosis slides observed.
- 6 Construct a PMI for this investigation that summarises the pluses (strengths), minuses (limitations) and suggested improvements (if you were to do it again).
- 7 Find out more about where and when mitosis occurs in plants. Create a poster to communicate your findings.
- 8 The cells that result from mitosis are identical to each other and the original cell. Suggest advantages and disadvantages of this feature.

INQUIRY: INVESTIGATION 3.13

Where are those germs?

KEY INQUIRY SKILL:

- processing and analysing data and information

Equipment:

sterile cotton buds

sticky tape

nutrient agar plates in

sterile Pasteur pipette

Petri dishes (3 per group)

marker pen

CAUTION Agar plates should not be opened after incubation.

- Swipe a sterile cotton bud across a surface of your choice (such as canteen counter, computer keyboard, phone mouthpiece or bin lid).
- Swipe the cotton bud across the surface of the agar. Be careful not to push down too hard. The cotton bud should not leave a mark on the agar.
- Use sticky tape to seal the plate around the edge.
- Use a marker pen to write your group's name and where you collected the sample from.
- Use a different cotton bud to swipe a part of your body (such as the inside of your nose, your teeth, inside your ear or your scalp).
- Swipe the cotton bud on the surface of the second agar plate, then seal and label it as before.
- Use the sterile Pasteur pipette to collect about 1 mL of water from a location of your choice (such as a fish

tank, puddle, local creek, school swimming pool or drain pipe).

- Pour the sample of water over the surface of the agar and swish it around. Seal and label the agar as before.
- Incubate the three plates upside down at 30 °C for 48 hours. Remove the plates from the incubator and observe the colonies of bacteria through the lid of the Petri dishes (do not open the Petri dishes).

DISCUSS AND EXPLAIN

- 1 Draw a diagram of each Petri dish showing the location and size of the colonies.
- 2 Colonies of bacteria tend to be smooth whereas colonies of fungus appear furry and are often larger. Do you have colonies of bacteria or fungi or both on your plates?
- 3 Look at the other groups' plates.
 - (a) Which of the surfaces tested by your class had the most microbes? How can you tell?
 - (b) Which body part tested had the most microbes?
 - (c) Which of the water samples tested contained the most microbes?
- 4 Explain why it would be dangerous to unseal the agar plates and lift the lid to look at the colonies of microbes.
- 5 Find out from your teacher how the plates are disposed of safely at your school.
- 6 Design an experiment to test whether antibacterial surface spray really does kill bacteria.

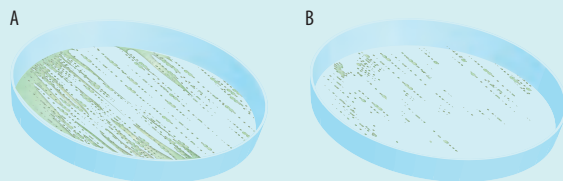
UNDERSTANDING AND INQUIRING

REMEMBER

- 1 Provide three reasons for cell division.
- 2 Suggest the relationship and sequence of the following: nucleus, DNA, cell, chromosome.
- 3 State a feature that the daughter cells produced by mitosis share with the parent cell.
- 4 If a cell is described as being a clone, what does this mean?
- 5 Identify a type of unicellular organism that:
 - (a) uses mitosis to reproduce
 - (b) does not use mitosis to reproduce.
- 6 Identify the difference between mitosis and cytokinesis.
- 7 Suggest a way that scientists can apply their knowledge of cell reproduction to benefit humans.
- 8 Outline the differences between disinfectants, antiseptics and antibiotics.

THINK AND DISCUSS

- 9 Charlotte wanted to find out if antibacterial soap really works. She prepared two agar plates. She swiped her fingers over the surface of plate A. She then washed her hands with antiseptic soap and wiped her fingers over the surface of plate B. She incubated both plates. Her results are shown below.



- (a) Write a conclusion for Charlotte's experiment.
 - (b) Which plate was the control?
 - (c) What were the independent and dependent variables in this experiment?
 - (d) Which variables need to be controlled in this experiment so that it is a fair test?
- 10 Before mitosis begins, the DNA in the cell is replicated. Suggest why this replication step needs to occur.
 - 11 Suggest the advantages and disadvantages of being a clone.
- ### INVESTIGATE AND CREATE
- 12 Find some examples of disinfectants and antiseptics. Select one and research how it works, reporting your findings as a 'scientific journal article'.
 - 13 Find out more details about mitosis and then use wool, plasticine or pipe cleaners to create your own model of the process of mitosis.
 - 14 Find out where and when mitosis occurs in plants. Create a poster to communicate your findings.
 - 15 *Entamoeba histolytica* is a unicellular organism that is a cause of diarrhoea among travellers to developing countries.
 - (a) Find out more about the disease that it causes, its life cycle and what you can do to avoid being infected by it.
 - (b) Prepare a brochure, poster or PowerPoint presentation that could be used to inform travellers.
 - 16 Investigate cell division in *Amoeba*, *Euglena* or *Paramecium* and create an animation to show how they reproduce.
 - 17 Find out how DNA is replicated in a cell and create an animation or PowerPoint presentation to communicate your findings to others.
 - 18 Investigate the differences between the structure of chromosomes in prokaryotes and eukaryotes, creating a model of each type of chromosome.
 - 19 Investigate the development of the microscope and its impact on our understanding of cell function and division. Present your findings as a short 'documentary' or play.
 - 20 Research examples of genetic engineering in which bacteria have foreign DNA inserted into them so that they produce human proteins. Communicate your findings as a newspaper article.
 - 21 *Clostridium perfringens* is one of the fastest growing bacteria, having an optimum generation time of about 10 minutes.
 - (a) If you started with one bacteria, plot on a graph how many bacteria there would be each hour over a 24-hour period.
 - (b) Find out more about the structure and reproduction of this bacterium.
 - (c) Find out why it is sometimes referred to as a 'flesh-eating' bacterium.
 - (d) Write a story that includes features of *Clostridium perfringens* as a key part of the storyline.
 - 22
 - (a) Find out why *Escherichia coli* (*E. coli*) counts at beaches are often stated in newspapers.
 - (b) How is the concentration of *E. coli* measured?
 - (c) Find out more about the structure and reproduction of *E. coli*.
 - (d) Create a model of this organism.
 - 23
 - (a) Find out the differences between disinfectants and antiseptics, providing examples of each.
 - (b) Select one of your examples and prepare an advertisement that could be used to market it.
 - 24 Search the internet for animations, songs and games that involve mitosis or binary fission. Use these to guide you in the development of your own creative lesson on this theory.

Skin 'n' stuff

eBookplus

eLesson

A cure?

Learn about the revolutionary new Australian trials to find a vaccine for skin cancer.

eles-0070

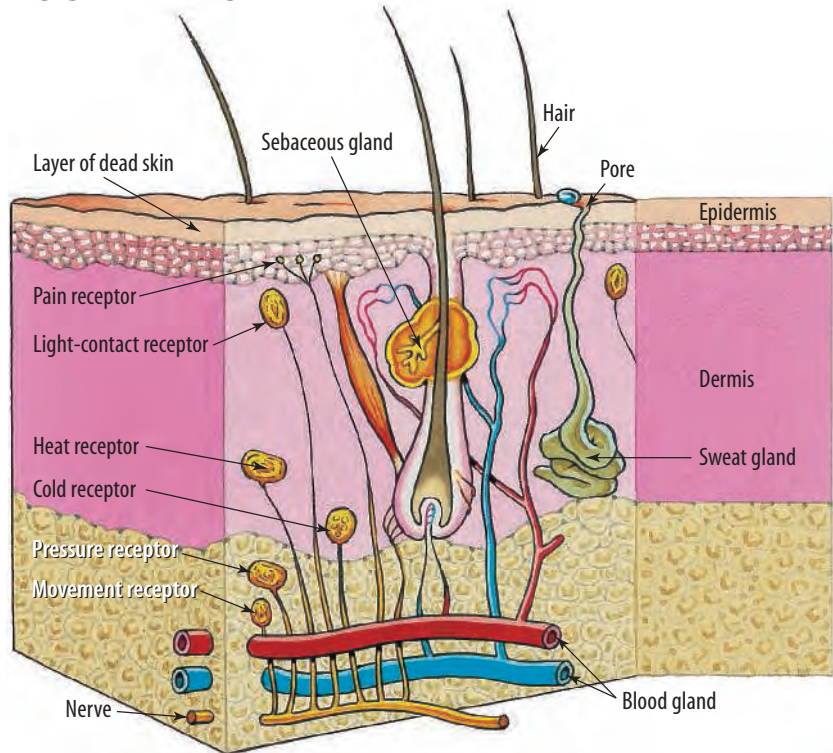
Your skin is made up of lots of cells that work together to keep you alive. A type of cell division called mitosis enables you to make skin cells for growth, repair and replacement. But what happens when something goes wrong?

Skin deep

Your skin is the largest organ of your body. As well as holding the insides of your body in, it also:

- protects your body from microbes that could cause disease
- is almost completely waterproof
- protects the inside of your body from chemicals and harmful radiation from the sun
- detects heat, cold, pain, pressure and movement
- helps control your body temperature
- forms vitamin D in sunlight
- releases water and other waste products.

The skin is divided into three layers.



Your skin varies in thickness between about 0.5 millimetres and 5 millimetres. The thickest part is on the soles of your feet. Skin consists of three layers.

The **epidermis** is the top layer. It contains several layers of cells. At the very top is a layer of dead skin cells, which flake off continually. At the bottom of the epidermis, new cells are always being produced. They push upwards on the older cells, moving them towards the surface. Below the epidermis is the **dermis**, which contains **receptors** for the sense of touch. It also contains **sweat glands** and many small blood vessels. Beneath the dermis is a thicker layer of fatty tissue, which acts as an insulator to help keep the body temperature constant. This fat has been stored by the body and can be used when needed to provide extra energy.

When you get hot, it is important that your body cools itself down so the blood remains at its constant temperature of about 37°C. Your sweat glands produce a liquid that is released through the **pores** at the surface of your skin. When the water in your sweat **evaporates**, it takes some of the heat out of your body.

Are you ticklish?

Are you more ticklish on some parts of your skin than others?

Below the surface of your skin there are many receptors that are attached to nerves. The nerves send messages to the brain. There are different receptors for heat, cold, light contact, pain, pressure and movement. They are all receptors to the sense of touch.

The light-contact receptors are nearer to the surface and closer together in some parts of your skin than others. It is those parts that are most sensitive to tickling. Some parts of the skin are also more sensitive to pain, heat, cold, pressure and movement than others. Your sensitivity depends a lot on how close together the receptors are to each other and how deep they are.

HOW ABOUT THAT!

Sweat doesn't actually smell until it is consumed by the bacteria that live on the surface of your skin. The regions around your armpits and external sex organs are warm and moist, providing ideal conditions for bacteria to grow and feed on the sweat. This is why these areas can get smelly.

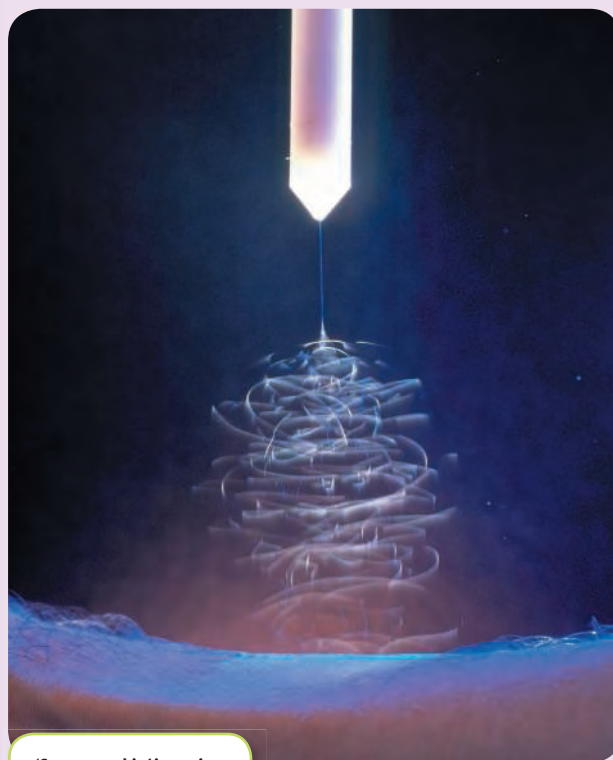
HOW ABOUT THAT!

Spray-on skin?

Burns can now be treated with skin that is literally sprayed on! Dr Fiona Wood (Australian of the Year in 2005) pioneered the development of 'spray-on skin'. Using the patient's own skin cells, it can be sprayed onto burnt areas and reduces scarring.



Dr Fiona Wood, pioneer of 'spray-on skin'



'Spray-on skin' in action

Sunsense

Skin cancer is the most common form of cancer in Australia. In fact, two out of three Australians are likely to get skin cancer at some time during their lives. The most serious forms of skin cancer are responsible for about 1000 deaths each year in Australia.

WHAT IS CANCER?

As the body's cells die, new cells are made to replace them. In a healthy person, just the right number of new cells are formed using a type of cell division called mitosis. Cancer can be considered as a disease of mitosis. Damage to the DNA in a cell can cause the normal regulatory processes in cell division to be ignored or overridden. This can result in uncontrolled cell division, a condition we call **cancer**.

This uncontrolled cell division can form a mass of cells called a **tumour**. The cells of a tumour are not specialised and cannot do the jobs of the cells that they are replacing. Some tumours still respond to the body's control mechanisms and do not spread to other parts of the body. These tumours are called **benign**. Others have uncontrolled cell growth and do spread, damaging vital organs. These are called **malignant** tumours or cancer. If cancer is detected early, the diseased cells can be removed or destroyed by chemotherapy or radiation. However, once cancer spreads, it is very difficult to control.

WHAT CAUSES SKIN CANCER?

The main cause of skin cancer is exposure to the sun. The ultraviolet radiation reaching

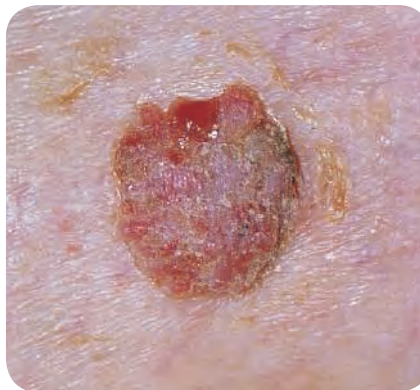
Earth from the sun is not visible. Ultraviolet radiation, which is also the cause of sunburn, is at its peak in the middle of the day when the sun is directly overhead. Ultraviolet radiation causes cancer in the cells of the epidermis, the top layer of the skin, because it damages the cells' genetic material, called DNA.

EARLY DETECTION

The key to curing skin cancer is early detection. Even melanomas can be cured in more than 95 per cent of patients if they are detected quickly. If you see a new lump or spot, or a changing freckle or mole, see a doctor promptly.

The three main types of skin cancer include the following.

Squamous cell carcinoma



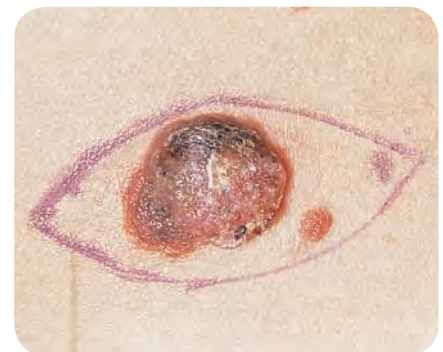
- Less common and more dangerous than basal cell carcinoma
- Appears as a red, scaly sore
- Usually found on the hands, forearms, face and neck, but can spread to other parts of the body
- Mostly affects people over the age of 40 who have been exposed to the sun for many years
- Kills about 200 Australians each year

Basal cell carcinoma



- Most common form of skin cancer and also the least dangerous
- Appears as a red, flaky lump on the skin
- Rarely spreads to other parts of the body but needs to be treated before it grows large or forms a deep sore

Melanoma



- Least common but most dangerous form of skin cancer
- First sign is a change in size, shape or colour of a freckle or mole, or the appearance of a new spot on normal skin
- Can spread quickly to other parts of the body
- Most common in adults aged between 30 and 50 years, usually caused by long periods of exposure to the sun during childhood and adolescence
- Cause of the most deaths from skin cancer — about 800 each year in Australia

Some questions about fun in the sun

Q: Is a suntan healthy?

A: No. A suntan is evidence that you have been exposed to the sun for too long. A suntan will not protect you from skin cancer. Fake suntan lotions do not offer protection from skin cancer either.

Q: Do I need to worry about sunburn or skin cancer when it's cloudy?

A: Yes. Although clouds block out a lot of the sun's visible light, they do not block out enough ultraviolet radiation to protect your skin completely, especially during summer. The graphs below show that light cloud cover has little effect on the harmful ultraviolet radiation reaching the ground on a summer's day in Sydney. Heavy cloud, however, decreases the amount of ultraviolet radiation reaching the ground by over 90 per cent.

Q: Do I need to use sunscreen when I wear a hat?

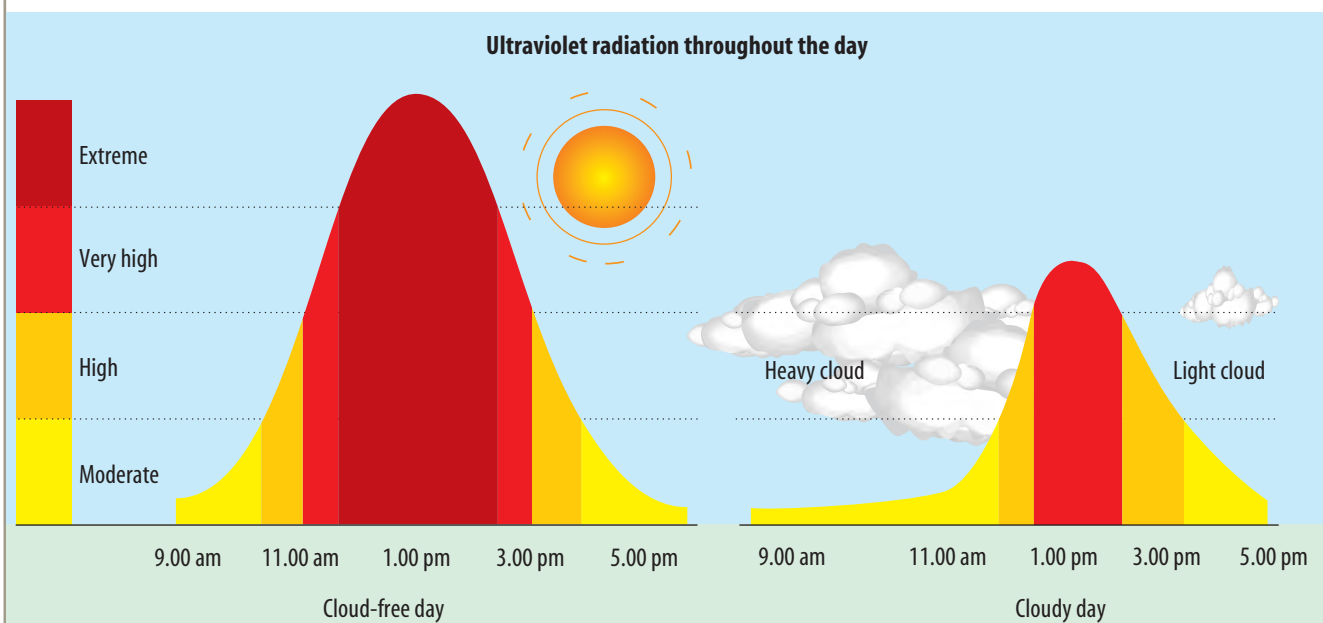
A: Yes. The sun's radiation is reflected from the ground and from water. Snow and sand reflect a lot of radiation, even on cloudy days. In addition, many hats, including baseball hats, do not protect you from direct radiation. Wide-brimmed hats or 'legionnaire' hats provide the best protection because they shade the neck and ears.

Q: What does SPF 30+ mean?

A: SPF stands for 'sun protection factor.' It allows you to estimate how long you can stay in the sun before your skin starts to go red. This period can be estimated by multiplying the amount of time that it takes your skin to redden by the SPF factor. For example, if your unprotected skin starts to burn after 10 minutes in the hot sun, proper use of SPF 4 sunscreen would allow you to remain in the sun for $10 \times 4 = 40$ minutes before burning starts. After that 40 minutes, you would burn, even with more sunscreen applied. An SPF water-resistant 30+ sunscreen reapplied every 2 hours would allow you to remain in the sun for at least $10 \times 30 = 300$ minutes before burning starts. SPF 30+ sunscreen blocks out about 97 per cent of the sun's radiation.

Q: What does 'broad spectrum' mean?

A: The Cancer Council NSW recommends a broad spectrum SPF 30+ sunscreen. Broad spectrum sunscreens offer protection from the three different types of ultraviolet radiation: UVA, UVB and UVC.



These graphs show how the ultraviolet radiation reaching the ground changes on a typical summer day in Sydney.

HOW ABOUT THAT!

An Australian drug company called Peplin has developed a gel made from a common weed called *Euphorbia peplus*, which has been used successfully to treat some skin cancers. The plant contains a cancer-fighting

chemical. Peplin has found a way of extracting this chemical from the plant and making it into a gel that can be applied to skin cancers. When the gel was tested, it cleared most skin lesions after just two days.

UNDERSTANDING AND INQUIRING

REMEMBER

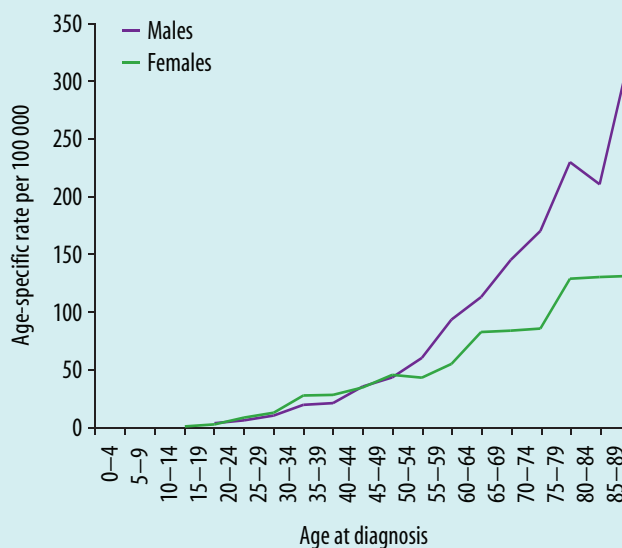
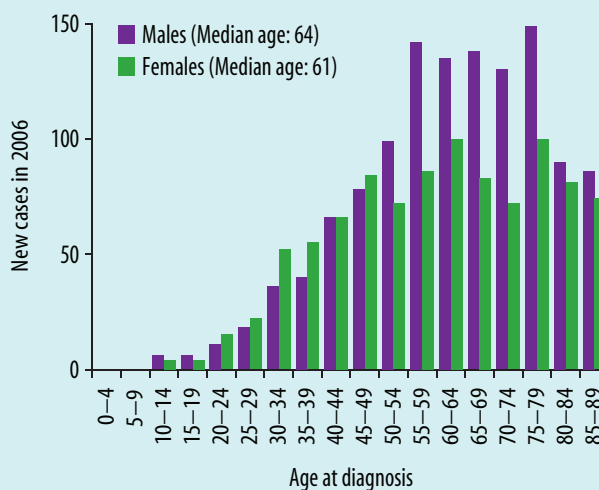
- 1 Identify the most serious form of skin cancer and how it is caused.
- 2 Outline the difference between a benign tumour and a malignant tumour.
- 3 State which part of the sun's radiation is the major cause of skin cancer and sunburn.
- 4 Identify the most dangerous time of day to be out in the sun.
- 5 Describe what you should look for on the skin when checking for signs of skin cancer.
- 6 List five ways that you can help protect yourself from skin cancer.

THINK AND DISCUSS

- 7 Melanomas occur mostly in adults over the age of 30. Why is it so important that young children and adolescents are aware of the dangers of the sun's radiation?
- 8 Daniel has very pale, sensitive skin that begins to burn after only eight minutes in the summer sun. He goes to the beach and takes a tube of SPF 6 sunscreen with him.
 - (a) If he doesn't go swimming, how long would he be able to sit in the sun before getting burnt, assuming that he applies his sunscreen correctly?
 - (b) If he used SPF 30+ sunscreen instead, would he be safe sitting in the sun all day? Give a reason for your answer.
- 9 Discuss the validity of the following statements.
 - (a) Cancer can be considered as a disease of mitosis.
 - (b) Melanomas are less dangerous than carcinomas.
- 10 Tissues are grouped together to form organs to help you function effectively. Describe how the following are important to your survival.
 - (a) Muscles
 - (b) Bones
 - (c) Skin

THINK AND REASON

- 11 Use the 2006 melanoma incidence graphs below to complete the following.
 - (a) Describe the pattern of melanoma incidence in Victoria in 2006.
 - (b) Suggest reasons for this pattern.

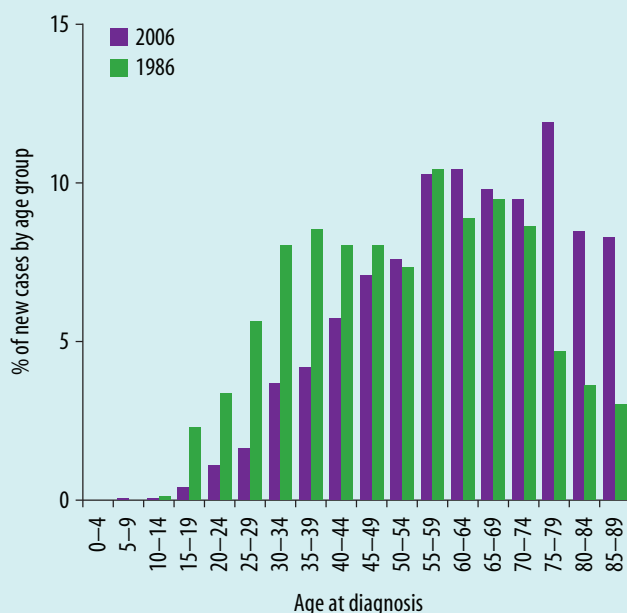


- (c) Identify the age group that has the highest number of new cases of melanomas:
- for males
 - for females.

- (d) Does the data suggest that there is a higher incidence of melanomas in males or females?
- (e) Suggest possible reasons for this data.

12 Use the 1986 and 2006 melanoma incidence graph below to complete the following.

- State the age group and year with the highest incidence of melanoma cancer.
- State the age group and year with the lowest incidence of melanoma cancer.
- Discuss your responses to parts (a) and (b) and suggest possible reasons for your findings.
- Describe differences in the patterns of melanoma incidence in Victoria between 1986 and 2006.
- Discuss your observations and suggest reasons for this difference.



CREATE AND DESIGN

- Design and construct a model that shows details of the three layers of skin.
- Construct a mind map that shows links between key scientific terms that are relevant to skin cancer. Use this map as a framework to create a song or poem about skin cancer that will increase awareness of types, causes, detection and prevention.
- Design a colourful poster that would encourage people to protect themselves from the sun's harmful radiation.
- Design and construct a multipurpose hat that shades the head and has at least one other purpose. Give your multipurpose hat a name. Prepare an advertising brochure and instruction manual for your hat.

INVESTIGATE AND DESIGN

- Design and carry out a survey (consisting of a series of questions) to find out whether people of different age groups protect themselves from the danger of skin cancer by wearing hats, shirts and sunscreens. By sharing your data with other members of your class, you may be able to form a sound conclusion.
- A number of schools describe themselves as being 'sunsmart'. Find out what the criteria are and who decides whether they are 'sunsmart'.
- Design your own 'Sunsmart' advertising campaign. Present your advertisement as a video clip with music.
- Research and report on one of the following science careers: dermatologist, plastic surgeon, skin cancer research scientist.
- Professor Graham Giles is a scientist at the Cancer Control Research Institute and is involved in Health 2020. Investigate and report on his research and that of other scientists at the institute.
- Associate Professor Greg Woods is investigating relationships between immune cells and cancer cells. Investigate and report on his research into skin cancer at the Menzies Research Institute.
- Dr Lisa Ebert at the Ludwig Institute for Cancer Research is investigating responses to a melanoma vaccine. Investigate and report on her research and that of other scientists at the institute.
- Use the **2020health** weblink in your eBookPLUS to research and report on examples of their investigations.
- Research and report on the difference between an oncologist and a pathologist.
- Use the **Molemate** weblink in your eBookPLUS to research and report on the 'Molemate' studies at the University of Western Australia.
- Obtain a selection of at least five different sunscreens. Identify criteria that could be used to determine their similarities and differences. Construct a matrix table with these criteria and record details for each sunscreen. Determine which sunscreen you would use. Which criteria did you use? Give reasons for your criteria. If you were to invent the 'ideal' sunscreen, what features would it have and why? Design an advertising brochure or advertisement for your 'ideal' sunscreen.

INVESTIGATE

- With a partner, play a guessing game to see how well you can use your sense of touch alone to identify 10 unknown objects.
You will need a blindfold and 10 objects of about the same size. Sandpaper, plastic, coins and pieces of carpet, polystyrene, nylon and wool would be ideal. See who can identify the most objects correctly.

eBook plus

Tiny size, big trouble

Just because you are tiny, doesn't mean that you can't cause trouble — think about how annoying mosquitoes can be! Sometimes it's the small things in life that make the biggest difference. The presence, absence or extreme levels of particular microbes can reflect the health of their habitat, whether it be an organism or an entire ecosystem.

'Down the hatch'

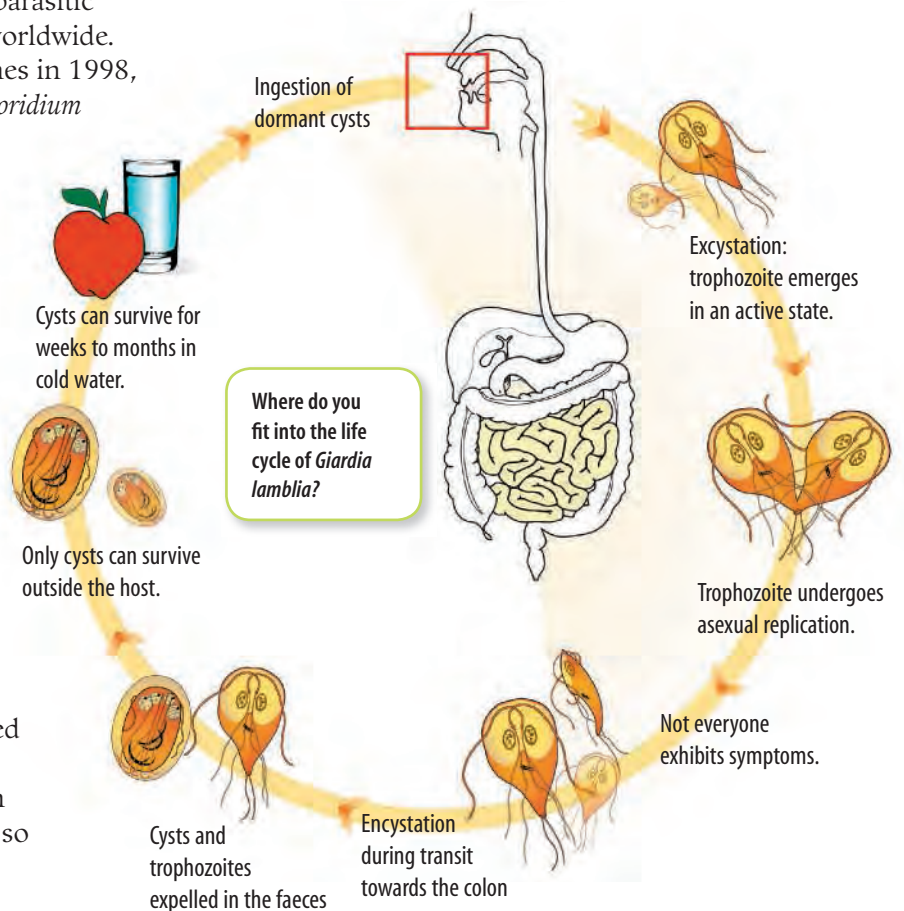
What's in that gulp of water? You may have swallowed a little more than you thought! As well as water, you may have also 'invited in' viruses, bacteria, protozoans, phytoplankton and zooplankton.

A protist (protozoan) by the name of *Giardia lamblia* has become quite well known for 'hitching a ride' in that gulp of water. These parasites are the cause of one of the most common parasitic gastrointestinal infections in humans worldwide. *Giardia lamblia* made newspaper headlines in 1998, along with another protozoan, *Cryptosporidium parvum*, when high levels of both were reported to be contaminating Sydney's drinking water supply.

Giardia lamblia use their flagella to move around, and they have a complex life cycle. The parasite can survive for a long period outside the body in an inactive form called a cyst. Once swallowed, the cyst is activated by your stomach acid and develops into the disease-causing stage. Using a huge sucker, they then attach themselves to the lining of your intestine, sucking your blood as their food source. After about ten days of infection you could have a million of them living off your blood supply and causing symptoms associated with gastrointestinal complaints. Some of their reproductive cysts pass through your digestive system and are excreted, so that another host can become infected.



Giardia lamblia are pear-shaped and quite large, usually being more than 6 μm in size.



Water wise

Living things need water to survive. Some living things also need to live in water to survive. In these ecosystems, there are links between the inhabitants to keep them balanced and healthy. Sometimes, however, these links can be broken or disrupted. This is when problems can occur that may result not only in an unbalanced ecosystem, but also in death.

TAKE A SWIM WITH ME

Escherichia coli (*E. coli*) is a type of bacterium found in our intestine. It usually causes us no harm and passes through our digestive system to be excreted. This enables it to be used as an indicator of sewage contamination in water. Contaminated sewage may contain dangerous or even deadly micro-organisms. It is for this reason that *E. coli* levels are tested and reported on at various beaches and swimming locations.



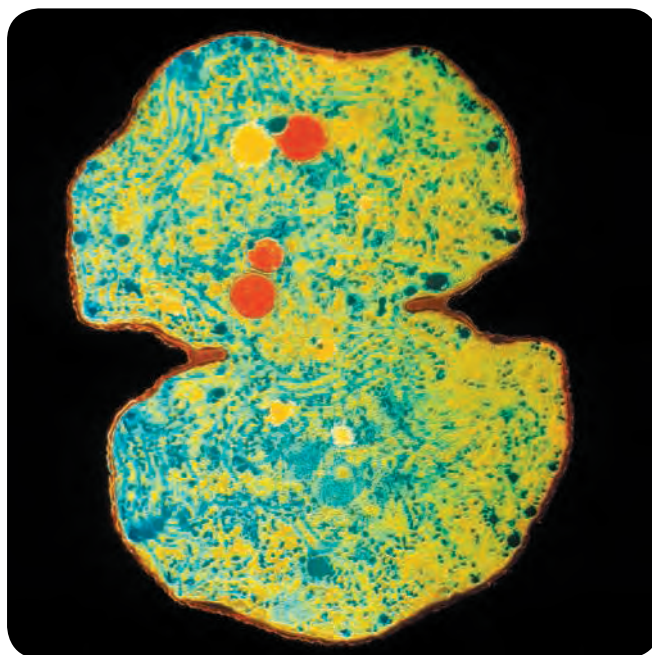
Electron micrograph of *E. coli*

BLOOM'N ALGAE

Algal blooms occur naturally and provide food for many aquatic organisms. Sometimes, however, they can cause harm. Algal blooms can cause large fluctuations in the levels of oxygen and pH (acidity) of the water and block sunlight penetrating through it. The species that cause these blooms may also be toxic to some of the aquatic organisms or even toxic or a skin irritant to humans. The presence of algal blooms can have economic as well as biological consequences.



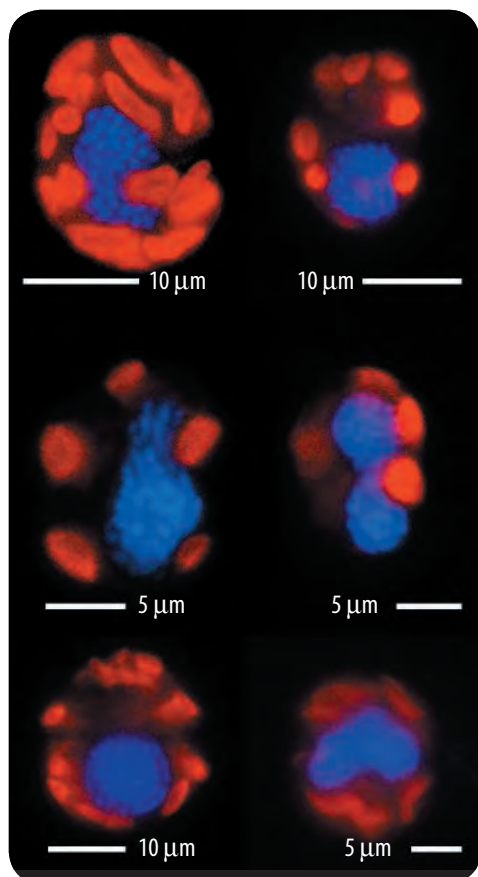
Algal bloom at Warragamba Dam, Sydney, NSW



Microcystis is an example of blue-green algae.

RED TIDE OF DEATH

Scientists at the University of Tasmania have discovered that two new types of algae are killing fish in the Southern Ocean. These algae have been found in abundance and when in full bloom produce a distinctive red-coloured tide. The university's scientists are working with the Australian Antarctic Division to try to establish the number of fish that are suffocating from the algae. This will enable sustainable fishing levels to be maintained.



Fluorescence microscopy can be used to identify the species that a cell belongs to, and can therefore help determine whether the cell may be of a dangerous type. In this image, the position of the chloroplasts shows as red and the nucleus as blue.



WHAT DOES IT MEAN?

The word *pathogen* comes from the Greek terms *pathos*, meaning 'disease', and *gen-*, meaning 'birth'.

INQUIRY: INVESTIGATION 3.14

Teeming with tiny . . .

KEY INQUIRY SKILL:

- processing and analysing data and information

Equipment:

light microscope

living protist specimens, such as Paramecium, Euglena, Amoeba

- Place a drop of a solution containing a particular type of protist onto a microscope slide and cover with a coverslip.
- Carefully observe under a light microscope.
- Draw, label and annotate your diagrams.
- Repeat the procedure so that you have observed three different types of protists.
- Repeat the procedure using pond water.

DISCUSS AND EXPLAIN

- While the protists observed are all unicellular, they have many differences. Use a matrix (see page 340) to summarise these.
- Discuss an interesting observation with your partner and formulate three questions for further investigation.
- Discuss your observations of the pond water. Investigate to identify some of the forms of life observed.

HOW ABOUT THAT!

Professor Gustaaf Hallegraeff is a scientist at the University of Tasmania. In his research he uses light, scanning and transmission electron microscopes to help him classify tiny marine organisms called phytoplankton. On the basis of his findings, he has produced publications to communicate information about harmful Australian microalgae.



Professor Gustaaf Hallegraeff

HOW ABOUT THAT!

Snap frozen

Australian Antarctic Division scientists are using a new field emission scanning electron microscope that magnifies specimens by up to 650 000 times. This allows them to observe features two million times smaller than the head of a pin. Snap-freezing technology is used, with the specimen being snap-frozen in super-cooled liquid nitrogen in temperatures of -210°C ! The snap-freeze process allows scientists to study more delicate specimens than were previously able to be observed.

UNDERSTANDING AND INQUIRING

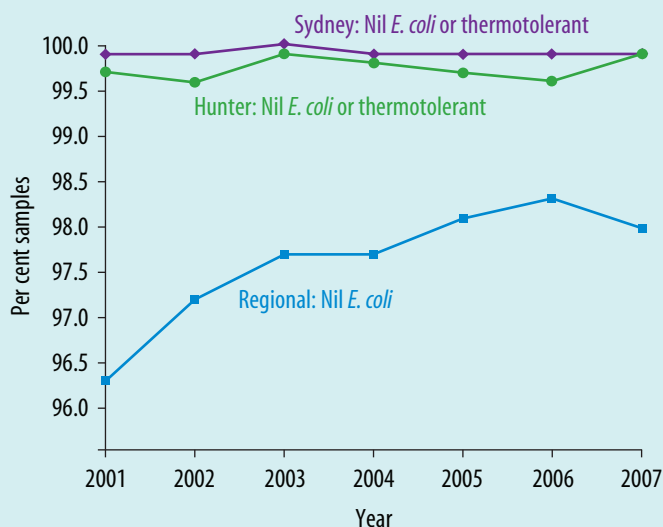
REMEMBER

- Describe the shape and size of *Giardia lamblia*.
 - Describe how *Giardia lamblia* obtains its food.
 - In which form can *Giardia lamblia* survive for weeks outside its host?
- Identify the genus to which each of the following organisms belongs.
 - Escherichia coli*
 - Giardia lamblia*
 - Microcystis* spp.
- Explain why levels of *E. coli* are measured in water.
- Are algal blooms always harmful? Explain.
- Outline problems associated with harmful algal blooms.
- Identify the type of organism that is responsible for causing red tides and killing fish in the Southern Ocean.
- Explain why scientists are trying to determine the actual numbers of fish being killed by the effects of red tides.
- State a function of fluorescence microscopy.
- Identify which location has the lowest bacterial counts. Suggest a reason for this observation.
- Find examples of *E. coli* counts in your local community waters.
- Graph your findings and discuss patterns in your class data.
- Suggest reasons for the patterns that you have observed.
- Pathogens are disease-causing organisms. Research and report on microbial pathogens in Australian waters.
- Research and report on one of the following.
 - Escherichia coli*
 - Microcystis* spp.
 - Giardia lamblia*
 - Cryptosporidium parvum*
- Research and report on an example of Australian research on one of the following topics.
 - Algal blooms
 - Microalgal pigments
 - Harmful Australian microalgae
 - Micropalaeontological studies
 - Coastal eutrophication
 - Taxonomy using light and electron microscopy

INVESTIGATE, THINK AND DISCUSS

- Use the graph below to answer the following questions.
 - Describe the pattern of indicator bacteria in each location between 2001 and 2007.
 - Identify which location has the highest bacterial counts. Suggest a reason for this observation.
- (a) Research and report on the diagnosis, symptoms and treatment of:
 - cryptosporidiosis
 - giardiasis.
- (b) Construct a Venn diagram to show how the conditions are similar and how they are different.
- Identify and research an issue related to micro-organisms in Australian waters.
 - Construct a PMI chart to summarise your findings.
 - Discuss your PMI chart with others in your team and add their comments.
 - Organise a class or team debate on the issue.
- Do microbes reflect marine health? Investigate this question by researching online and justify your response.

Indicator bacteria counts in drinking water, Sydney, Hunter and regional water supplies, NSW 2001 to 2007



eBookplus

- Use the **Water quality** weblink in your eBookPLUS to check out the latest daily water quality results from water filtration plants in Sydney and obtain current *Giardia* and *Cryptosporidium* data.

Target maps and single bubble maps

1. Draw three concentric circles on a sheet of paper.
2. Write the topic in the centre circle.
3. In the next circle, write words and phrases that are relevant to the topic.
4. In the outer circle, write words and phrases that are not relevant to the topic.

To identify (target) what is part of (relevant to) the topic and what is not

why use?

how to ...?

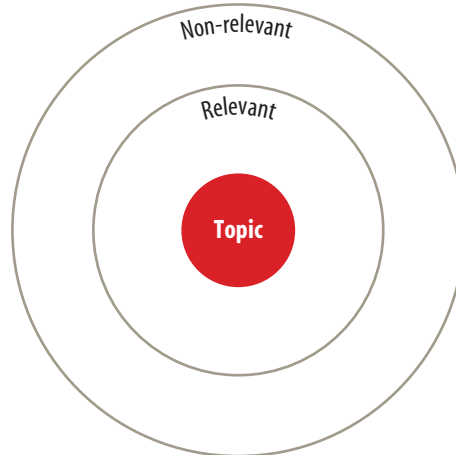
How can we find out what is relevant?

question

Circle map

also called

Target map



comparison

Similarity

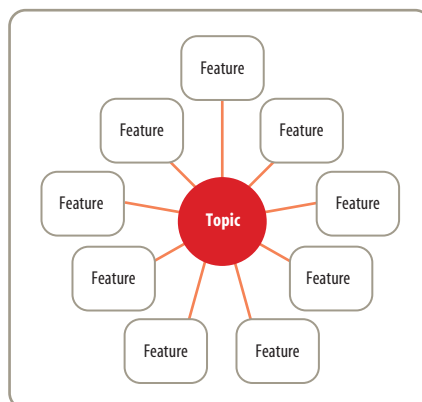
Both identify and describe the range of the content.

Difference

Single bubble maps do not identify the non-relevant material.

Single bubble map

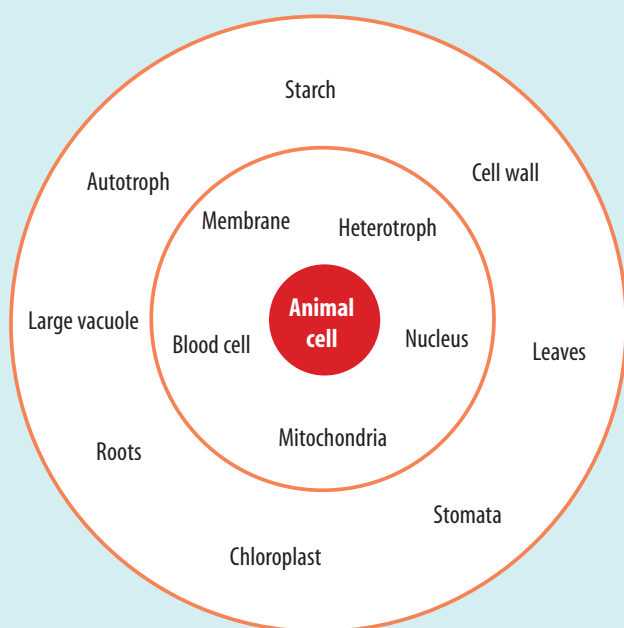
example



UNDERSTANDING AND INQUIRING

THINK AND CREATE

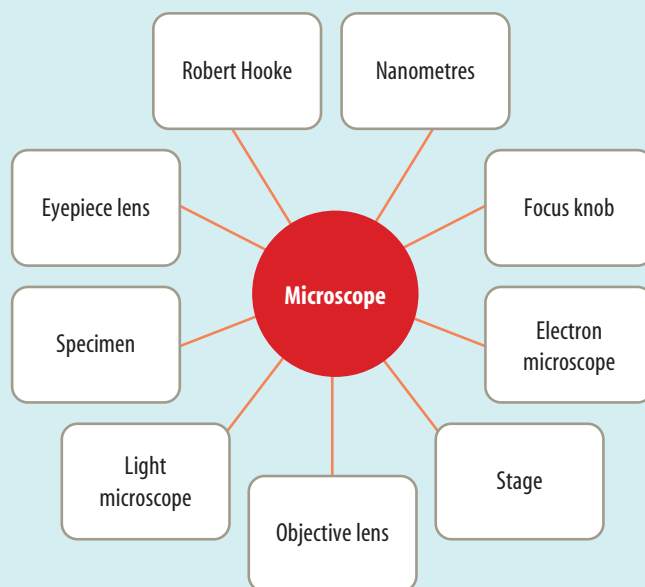
- Use the target map below to answer the following questions.
 - List the content that is relevant to animal cells.
 - List the content that is not relevant to animal cells.
 - Using the words in the target map, construct a target map that is relevant to plant cells.
 - Identify which words are relevant to both plant and animal cells.
 - Suggest why plant and animal cells both have these features in common.



- Use the terms in the box below to construct target maps that are relevant to:
 - plants
 - animals
 - fungi
 - protocists
 - prokaryotes (monera).

multicellular	chloroplast	<i>Euglena</i>
prokaryote	bacteria	mushroom
eukaryote	fern	yeast
nucleus	alga	lizard
cell wall	<i>Paramecium</i>	sponge
large vacuole	unicellular	moss
xylem	cell membrane	blood cells
possum	stomata	phloem

- Construct a single bubble map to identify:
 - types of plant cells
 - types of animal cells
 - scientists who have contributed to our knowledge of cells
 - examples of body systems
 - functions of skin
 - issues related to stem cells.
- Use the information in the single bubble map below to construct a target map of the parts of a light microscope.



- Use the internet to find images of at least five different types of zooplankton.
 - Carefully observe your zooplankton images, recording key features of each in single bubble maps.
 - Construct target maps for each of your zooplankton to show how they are different from the other zooplankton.

CELLS

- name and state the function of the parts of a light microscope
- describe how to prepare a specimen for observation under a light microscope
- observe and sketch labelled diagrams of cells and other specimens as viewed under a light microscope
- suggest why stains are used in the preparation of microscope slides
- explain the significance of the invention of the microscope to biology
- outline the contributions of three scientists to our understanding of cells
- state examples of different types of cells and relate their structure to their function
- describe the differences between unicellular and multicellular organisms
- name a type of cell division involved in growth and repair
- explain why not all cells have the same structure
- use differences in cell structure to classify organisms into groups
- explain how cell structure can provide us with evolutionary information

MULTICELLULAR ORGANISMS

- sort the following in order of relative size, from biggest to smallest: tissue, atom, organ, molecule, cell, system, organelle
- name a system in the human body, describe its function and give examples of the types of cells it contains

ECOSYSTEMS

- give examples of how unicellular organisms can have big impacts on ecosystems

SCIENCE AS A HUMAN ENDEAVOUR

- outline developments in the understanding of cells and how this knowledge has affected research areas such as health and medicine
- describe the development of the microscope
- outline the effect microscopes have had on our understanding of cell functions and division
- describe how people use understanding and skills from across the disciplines of science in their occupations
- provide an example of the role of knowledge of cells and cell divisions in the area of disease treatment and control

INDIVIDUAL PATHWAYS

eBookplus

Activity 3.1
Investigating cells
doc-6048

Activity 3.2
Analysing cells
doc-6049

Activity 3.3
Researching cells
doc-6050

eBookplus Summary

eLESSONS

Inside cells

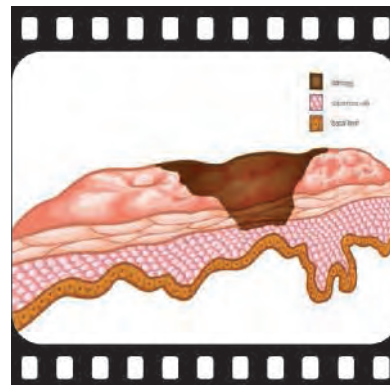
Learn about the building blocks of life called cells and organelles in this animated video lesson, looking closely at the difference between the make-up of animal and plant cells. A worksheet is attached to further your understanding.



Searchlight ID: eles-0054

A cure?

Skin cancer is the most common form of cancer in Australia with around 400 000 people diagnosed each year. Learn about the revolutionary new trials led by Australian scientists to find a vaccine for skin cancer. A worksheet is included to further your understanding.



Searchlight ID: eles-0070

INTERACTIVITIES

Microscope parts

This interactivity focuses on the microscope. You must select the parts of the microscope that best fit a series of descriptions. Instant feedback is provided.

Searchlight ID: int-0205

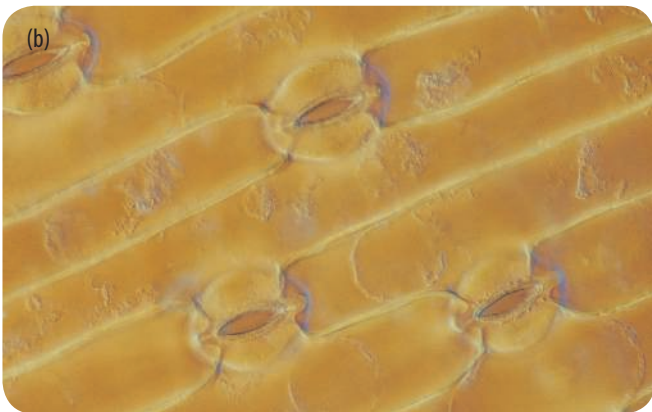
Cell jobs

This interactivity tests your ability to match a number of different types of cells with their roles in the body. Instant feedback is provided.

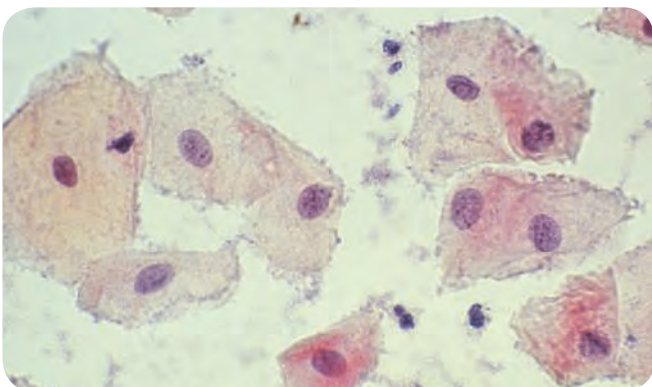
Searchlight ID: int-0206

LOOKING BACK

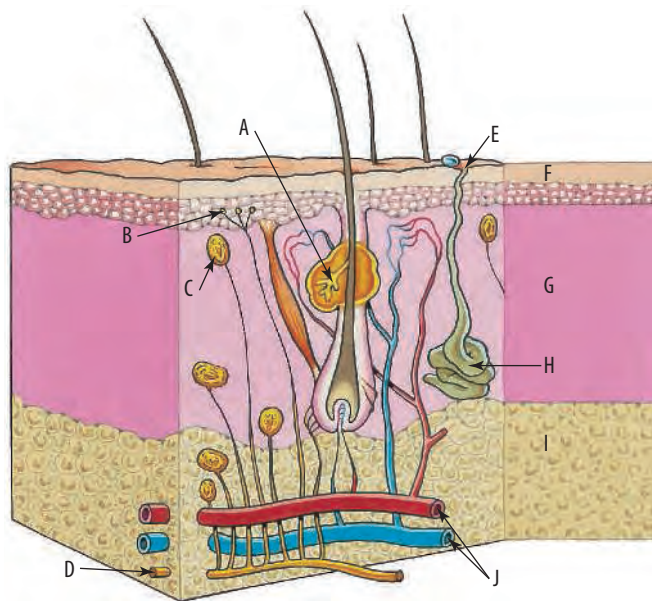
- 1 (a) Brainstorm as many 'cell'-related words as you can, writing them on a piece of paper.
 (b) Pair up with another class member and add any of their words that you missed. Ask your partner what these words mean if you are unsure.
 (c) On a new piece of paper, work with your partner to group or link words to make a concept, cluster or mind map.
 (d) Compare your map with that of another pair in the class, adding as many more bits and pieces as you can.
- 2 Which of the following types of microscopes were used to take the photos shown below?
 - Scanning electron microscope
 - Light microscope
 Give reasons for your answers.



- 3 Make a sketch of these human cheek cells.



- 4 (a) Why do you think that cells have been described as 'living factories'?
- (b) Think of a typical plant or animal cell. Make a list of all of the different parts and organelles. If the cell was a living factory, what might be the job of each listed part?
- (c) Write a play to act out what happens in cells and perform it with others in your class. What sorts of things were easy to show? What sorts of things were hard to show? If you were to rewrite the play, what might you change and why?
- (d) Convert the classroom into a giant cell! Take photos and then add information to them on a poster.
- 5 Construct a Venn diagram to show the similarities and differences between light microscopes and electron microscopes.
- 6 Explain the significance of the invention of the microscope in terms of how we see the world.
- 7 Suggest why the invention of microscopes led to the development of new scientific language and classifications.
- 8 Carefully observe the diagram of the skin below. Match the letters on the diagram with the following labels: epidermis, dermis, fatty layer, light receptor, sweat gland, blood vessels, sebaceous gland, pain receptor, nerve, pore.



- 9 The body tissues and their main jobs have been jumbled in the table below. Redraw the table and correctly match the type of tissue to its main job.

Tissue	Main job
Skeletal	Conducts and coordinates messages
Nerve	Supports and protects
Blood	Enables movement
Muscle	Carries oxygen around the body

10 Copy and complete the table below:

Cell feature	Plant cells	Animal cells	Fungal cells
Cell wall	✓	✗	
Cytoplasm			
Cell membrane			
Chloroplast			
Nucleus			
Large vacuole			

11 Draw and label a typical plant cell and a typical animal cell.

12 What's green and eats porridge? Identify the parts of the microscope on the right and use the code below to find out the answer to this riddle.

Code:

O = revolving nose piece; U = objective lenses;

S = coarse focus knob; K = fine focus knob;

D = microscope slide; L = stage slide clip;

C = base; O = mirror; L = iris adjustment;

I = stage; M = eyepiece lens

13 Unscramble the words using the clues provided.

(a) Control centre of the cell SEUNCLU

(b) Surrounds the cell ERAMMBNE

(c) Contains cell sap OCVAUEL

(d) Part of the cell between the cell membrane and the nucleus CATOPLMYS

(e) Building blocks of all living things LELSC

(f) Living things ASMOGNIRS

14 (a) Match the following cell names to the diagrams on the right.

Euglena

Paramecium

onion epidermal cells

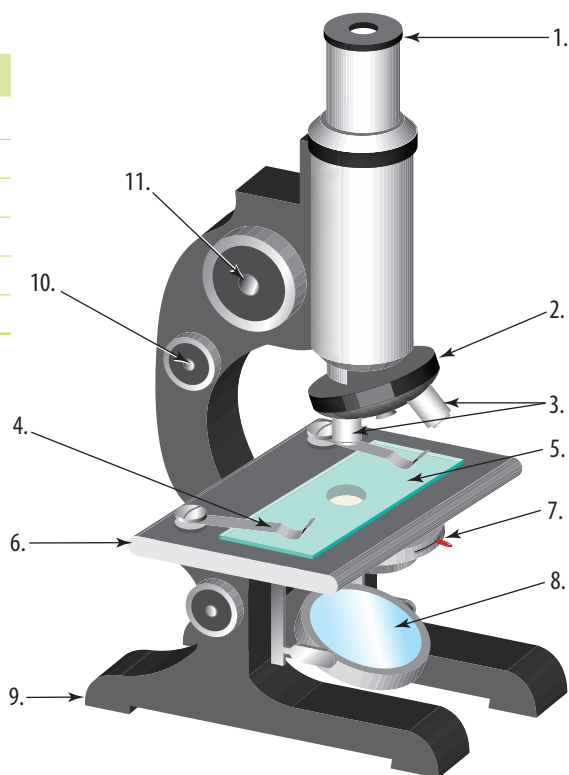
nerve cell

sperm cell

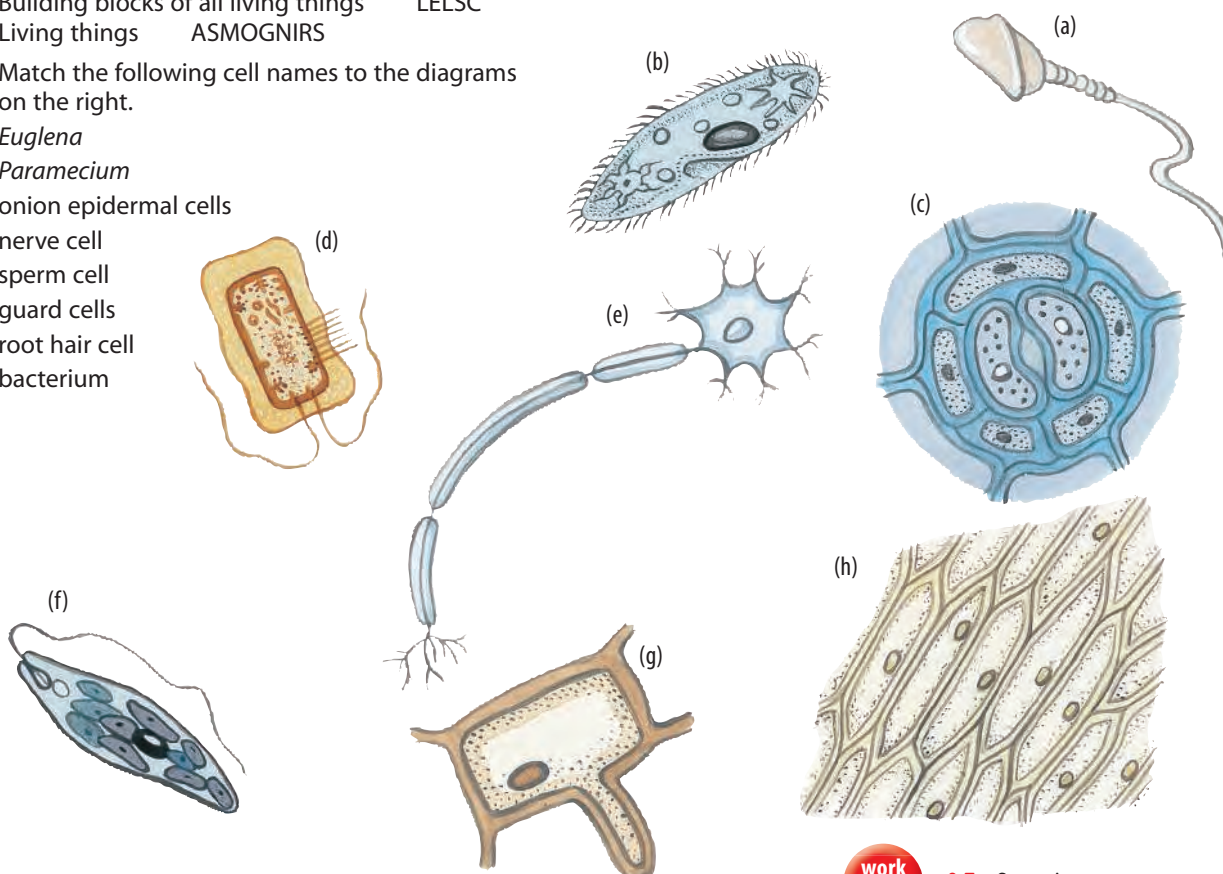
guard cells

root hair cell

bacterium



1	2	3	4	5	6	7	8	9	10	11
---	---	---	---	---	---	---	---	---	----	----



(b) To which kingdom does each of these cells belong?



3.7 Summing up
3.8 Looking back